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THE
ENGINEERING MAGAZINE

VOL. XIX. APRIL, 1900. No. 1.

THE CAPE-TO-CAIRO RAILWAY.

By John Hartley Knight.

ASH-PIT AND TANK, MAFEKING.

"APT alliteration," quite as much as the magnetic personality of Mr. Cecil Rhodes, has popularised the Cape-to-Cairo railway scheme. There is much in a name. To countless thousands of English-speaking people there is something strangely fascinating in the phrase "Cape to Cairo"—far more so, maybe, than in any similar alliterative example, such as "London to Liverpool" or "New York to Yokohama." And the fascination is due not so much, perhaps, to the mere alliteration as to the vast extent of territory, mystic, wonderful, which the phrase embraces. From Cape Town to Cairo! The imagination reels at the tremendous prospect opened up by the phrase, and at the apparently insuperable difficulties confronting those who would dare attempt to annihilate space and bring the searchlight of civilization to bear upon the savagery and ignorance of what even now is still a very Dark Continent. On the other hand, five thousand odd miles—the sum of the distance separating Cape Town from Cairo—are as nothing to the resourceful railway engineer, and

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It is heartily to be hoped that the prospects of peace in South Africa, apparent as this issue goes to press, may be fully realised. In any event, the close of the war is certain to be followed by an energetic opening up of the country by the pushing of various develop-

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one marvels not so much at the vastness of Mr. Rhodes' scheme as at the fact that its conception should have been so long in the being. Five or six years ago the "man in the street" knew nothing, and cared less, about the matter. Nowadays it fills the popular mind and its daring is discussed on every side. Mr. Rhodes is credited with its conception—yet it is by no means certain that this should be so. The Cape-to-Cairo scheme, as such, was of slow growth. In 1879 some such scheme possessed the fertile mind of Sir James (then Mr.) Sivewright, then superintendent of telegraphs to the Cape Government. But his was a telegraph scheme pure and simple. In 1888, Sir Charles Metcalfe, Bart., the well-known engineer, conceived the idea of calling the then projected Bechuanaland railway the "Central African Trunk Line"—thus clearly foreshadowing the Cape-to-Cairo notion. In 1891 that instinctive writer, Mr. E. P. Mathers, was prophetically moved to inscribe on the cover of his book "Zambesia" the injunction to prospective railway travelers to "Book from Cape Town to Cairo via the Victoria Falls." Two years later we find the *Times*, in a leading article, discussing the proposed Bechuanaland line and

A SALOON CARRIAGE, BECHUANALAND RAILWAY.

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ment projects, of which the Cape-to-Cairo Railway is the most comprehensive and most magnetic.

Former articles in THE ENGINEERING MAGAZINE treating other phases of the movement have been:

The Transvaal Mines and the Boer Government. Dr. F. H. Hatch. Aug., 1899.
South African Questions from an Engineering Standpoint. Albert Williams, Jr. Dec., 1899.
John Hays Hammond on the South African Situation. Charles Buxton Going. Jan., 1900.
The Economic Conquest of Africa. H. G. Prout. Feb., 1900.
Gold Mining Prospects in Rhodesia. R. R. Mabson. Mar., 1900.

observing that the approval of the Government to the same "brings appreciably nearer the accomplishment of the aim of linking the British possessions of South Africa together from the Cape to the Zambesi, which has been the acknowledged goal of Mr. Rhodes' South African policy." Here we are distinctly informed that the Zambesi—not Cairo—was Mr. Rhodes' goal. The extension to Egypt was apparently not thought of by the South African Colossus until 1892—and only then, it would appear, in association with a telegraph scheme. Some time elapsed before the phrase "caught on" with the public, and to-day it is more popular than ever. Little Englanders may sneer at it and the Labouchères of the press may decry it as being impracticable, unprofitable, and useless. But the fact remains that the man in the street loudly approves it. Why? Because, in the first place, "Cape to Cairo" is irresistible as a phrase and, in the second, because in his heart of hearts he really and truly thinks there is "something in it."

The first stage of the Cape-to-Cairo line was completed long before Mr. Rhodes' name became linked with the phrase. This was as far back as 1859, six years after Mr. Rhodes was born, when the first railway in Southern Africa was begun between Cape Town and the little town of Wellington—a distance of 58 miles! Cairo was not the

INTERIOR OF SALOON CARRIAGE, BECHUANALAND RAILWAY grand objective in those days. It is interesting to recall that the first sod of the line in question was turned by that great statesman, the late Sir George Grey, then Governor of Cape Colony. The line was constructed by an English company, and like many similar undertakings it cost more than the estimated amount—nearly half-a-million—to construct. The discovery of diamonds in Griqualand west, in 1867, gave the first great impetus to railway construction in the sub-continent. In 1872 the line was extended another sixty miles or so to Worcester, at a cost of £266,000, the money being raised in Europe. The chief engineering difficulties of the first great link in the Cape-Cairo line occur in the first hundred miles, in the mountainous and picturesque region known as Hex River, where the line climbs to an altitude of 3,588 feet. For a distance of more than twenty miles hereabouts the gradients are 1 in 40 and 1 in 45, with curves of five chains radius. Extensive rock cuttings and precipitous embankments are the characteristics of this section of the Cape railway. From Worcester onwards—passing Matjesfontein, Kimberley, and Vryburg (the last named being 774 miles from Cape Town) the line runs on comparatively smooth ground and through what is known as the Karoo, the praises of which have been so eloquently sung by the gifted authoress, Olive Schreiner. In 1874 railway construction on a large scale was resolved upon at the Cape, and ere long the iron horse—whose destination a later generation is resolved shall be Cairo—was well on its way to Kimberley. It would be impossible within the compass of this article to do anything like justice to the difficulties and disappointments which beset the pioneers of the Cape-to-Cairo line. Suffice it to say that on November 28th, 1885, the first train from Cape Town steamed into Kimberley—to the unspeakable gladness of the inhabitants. Another five years were to elapse before the 127 miles separat-

TRACK LAYING ON THE RHODESIAN RAILWAYS.

ON THE ZAMBESI.

ing Kimberley from Vryburg were metalled—not, however, that the line actually took all that time to construct. This brings us down to 1890—a year after the incorporation by Royal Charter of the British South Africa Company, and three years after the world had been startled by the discovery of the auriferous wealth of the Witwatersrand. Mr. W. T. Stead once very happily observed that, but for Mr. Rhodes, the Cape-to-Cairo line would have got itself built in sections and it would never have been discovered that it was a Cape-to-Cairo line until the last gap had been bridged and the trains were actually running. There is considerable truth in this. Although we have evidence that the Cape-Cairo idea was foreshadowed by others than Mr. Rhodes, yet it was reserved for him to, as it were, crystallise the idea and fire the fancy of his fellowmen with a seemingly impossible and daring project. Perhaps it was in 1890—the year of Mr. Rhodes' first premiership at the Cape—that the Cape-Cairo scheme began to be talked about. For three years, however, the iron horse remained stabled at Vryburg; and in 1893, the Bechuanaland Railway Company—now known as Rhodesia Railways, Limited—was formed for the purpose of constructing and working a railway from Vryburg to Mafeking and thence northward towards the River Zambesi—not, be it observed, merely to Palapye or Bulawayo, but right away north to the Zambesi. The contractors of the company were Messrs. Pauling & Co., Ltd. (who had built the line from Kimberley to Vryburg) and the engineers were Sir Charles Metcalfe and Sir Douglas Fox. The gauge was to be as on the Cape line, viz., 3 feet 6 inches. The British South Africa Company advanced the money required for the construction of the line, taking 6 per cent. debentures issued by the railway company, which were afterwards exchanged for an equivalent amount of 5 per cent. mortgage debentures or debenture stock. The contract price per mile—90½ miles altogether—was £2,575. The section to Mafeking was opened for traffic in October, 1894, and the net earnings for the first ten months were equal to 4 per cent. per annum on the cost of the section.

A word at this juncture as to the country in which the second half of the Cape-Cairo line is situate. It is of the same level character as distinguishes, as we have said, the country from Worcester in the Cape Colony to Vryburg. "The whole country," to quote Sir Henry M. Stanley's description of the journey to Bulawayo, "seems to have been created for railway making. It offers as few difficulties as the London Embankment. Hyde Park is extremely uneven compared with it." For nearly a thousand miles, the distinguished traveler goes on to tell us, the railway sleepers have been laid at intervals of 30 inches on the natural face of the land; the rails have been laid across these and connected together; the native navvies have scraped a little soil together, sufficient to cover the steel sleepers, and the iron road was thus ready for traffic. The scenery of Bechuanaland, which to a man accustomed to green fields and flowing rivers would appear a dry and waterless region, found much favour in the experienced eyes of Sir Henry Stanley, who tells us that he has seen nothing between the immediate neighbourhood of the Missouri River and the Rocky Mountains to surpass it; and he adds that the prairies of Nebraska, of Colorado, and Kansas—as he had seen them in their uninhabited state—are inferior in appearance to these "richly ochreous" plains.

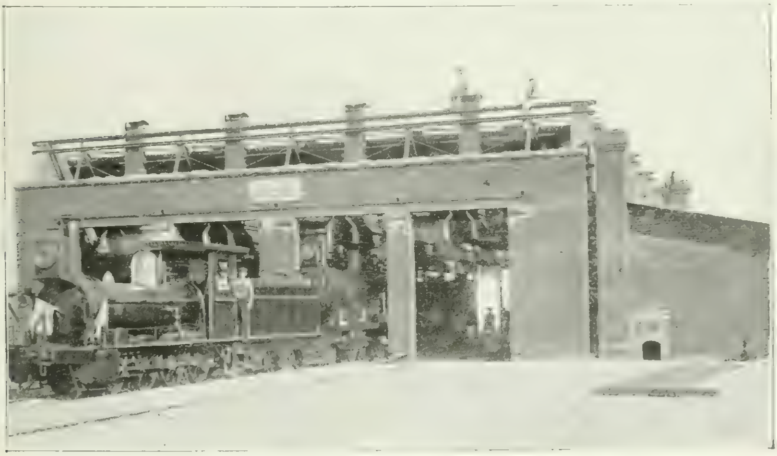
ENGINE SHED, MAFEKING.

TURNTABLE, MAFEKING.

The Bechuanaland Railway Company had no intention of letting the grass grow under their feet. The Mafeking extension was no sooner completed than the contractors started in earnest on the next

BALLASTING THE ROAD.

section towards Cairo, and before the end of 1894 the line to Gaberones, Palapye, and Bulawayo was well under way. The line to Gaberones—110½ miles—was opened in July, 1895; and two years later the whole section to Bulawayo was triumphantly completed. From Cape Town to Bulawayo is 1,360 miles. The inability of the Cape Government to transport material quickly helped to retard construction, and Bulawayo became so impatient to see the iron horse that Mr. Rhodes was induced to offer the contractors an extra £200 per mile to lay a mile of metal a day. The result was that the "last lap" was so hastily laid that, with the first heavy rains, the contractors had to face



THE FIRST ENGINE IN THE NEW SHED, MAFEKING.

STATION YARD AT BULAWAYO.

some serious wash-aways. All that, however, was subsequently remedied, and when once the trains were able to run into Bulawayo the contractors went back over the line and carefully completed the works in accordance with their contract. Thereupon the railway company became entitled to an annual subsidy for a period of years from the Imperial Government and the British South Africa Company, and the company are now subsidised to the extent of £30,000 per annum.

November 4, 1897, was a very great day in the history of Bula-

THE FIRST TRAIN INTO BULAWAYO.

wayo. On that day a number of the leading men of South Africa, and some distinguished visitors from England, foregathered in the town to celebrate the local arrival of the iron horse. Mr. Rhodes was ill with fever and could not be present; but he was not forgotten. Sir Alfred Milner, the High Commissioner, at a banquet given on the occasion, paid a high tribute to the foresight and energy of Mr. Rhodes, and said that even his bitterest enemies would admit his title to a place of honour that night, for he was not only managing director of the line, but prime mover in its construction. "Few events of the century," wrote Sir Henry Stanley, "surpass it in interest and importance"—marking, as it did, "the conclusion of an audacious enterprise." Meanwhile, Mr. Rhodes' twin scheme—the laying of a telegraph line from north to south—had made even greater progress. A visit to Cairo in 1873 convinced the right honourable gentleman that it was impossible, then, to advance his project at that end of the continent. The Mahdi could not be "squared," Mr. Rhodes found; he was an insuperable difficulty. The work must therefore be prosecuted from the south. The scheme had long been carefully thought out and Mr. Rhodes threw himself into its execution with characteristic vigour. The telegraph line runs from Umtali, in Mashonaland, to Tete,

TEMPORARY CROSSING OF THE SHASHI RIVER, THE BOUNDARY BETWEEN MATABELELAND AND THE BECHUANALAND PROTECTORATE.

A 50-FOOT PLATE-GIRDER BRIDGE.

thence it goes in an easterly direction to Blantyre in British Central Africa, from Blantyre to Zomba, and thence to the western shore of Lake Nyassa. From Karonga the line is completed to Abercorn, at the south end of Lake Tanganyika; and by agreement with the German Government, the line will be carried through German East Africa to Uganda and so northwards, to connect with the line at Khartum. The authorised capital of the African Trans-Continental Telegraph Company is £300,000, in £1 shares, of which £170,320 has been subscribed and called up.

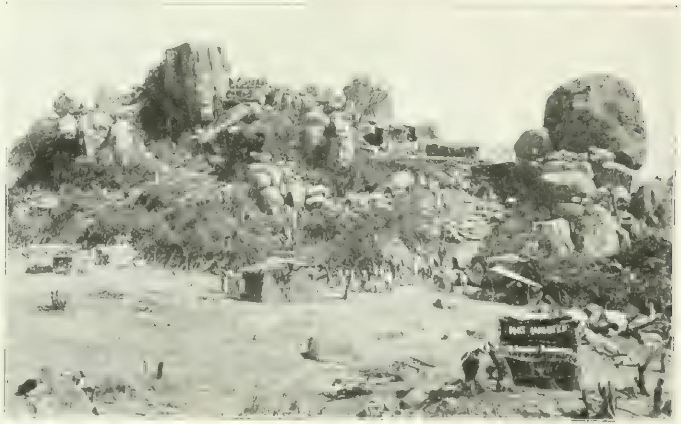
MACLOUTSIE BRIDGE. TWO SPANS OF ONE HUNDRED FEET EACH.

The Macloufsie is the first large stream south of the Shashi. Both are tributaries of the Limpopo.

Fort Umlugulu, on the Bulawayo-Pretoria Road.

Fort Manzinyama, about 30 Miles Southeast of Bulawayo.

Cumming's Store, where Gifford Had a Fight with Matabele.



Fort Halsted.

MILITARY OUTPOSTS IN THE TERRITORY OPENED UP BY THE CAPE-TO-CAIRO ROAD.

But to return to the railway. All the world knows how, in the early part of 1899, Mr. Cecil Rhodes came to England for the express purpose of getting the Imperial Government to assist him in extending the line from Bulawayo to Lake Tanganyika—roughly 800 miles. The Government hemmed and hawed for so long a time that Mr. Rhodes looked elsewhere for the financial help he needed—and found it. The Rhodesian Mining Companies subscribed £500,000 and the British South Africa Company guaranteed £3,000,000, the money being raised by means of 4 per cent. debentures, in instalments of £600,000 over a period of five years. Just before this happy issue out of his financial afflictions Mr. Rhodes visited Berlin to seek the sympathies of the German Government. His reception by the Kaiser and his people was extremely cordial, and before he left the German capital he had practically arranged that his telegraph and railway should both run through German East Africa. Mr. Rhodes went to Berlin with a concession in his pocket to take his lines through Belgian territory, but he preferred the German route. The section of the railway line to pass through German territory will represent a seventh of the whole line. Both the railway and telegraph will be constructed with German capital, although, of course, English capitalists will participate. There are two important features in the Anglo-German agreement. One is that the British South Africa Company binds itself not to continue its railways to the west coast of Africa from the territories of Rhodesia or Bechuanaland south of the 14th degree of latitude, save from a point on the Anglo-German frontier to be determined by special agreement with the German Government. Further, the British South Africa Company is bound not to construct a railway north of the 14th

AN ENGINE IN THE YARDS AT BULAWAYO.

degree of latitude from the above-mentioned territories to the West African coast until a railway line has been constructed south of that degree of latitude, through German South-West Africa. The next great link in the Cape-Cairo chain embraces what is perhaps at once the most interesting and richest portion of the route. The first half from Bulawayo to Zumbo, on the Zambesi—passes through the gold districts of Mafungabusi and Lomagundi and also skirts the Sengwe coal area. Sir Charles Metcalfe, who recently surveyed this part of the country, gives some interesting details of its geographical features. The country, he says, is a high level for the first 150 miles from Gwelo, the height being about 4,000 feet; when within 50 miles of the Zambesi, the surveying party came upon a high range of mountains 20 miles in breadth and from 3,000 to 4,000 feet in height, consisting of innumerable quartz reefs and slates almost on edge. From this range there is an abrupt drop of 1,200 feet to the level of the country near the Zambesi, which is some 1,800 feet above the sea. The Zambesi just above Kariba Gorge—through which, in all probability, the railway will pass—is about a quarter of a mile in width, and at the junction of the Sanyati River it narrows to the passage called Kariba Gorge, which for a mile in length does not exceed fifty yards in width. This section of the line passes within easy distance of the magnificent Victoria Falls—the Niagara of Rhodesia—to say nothing of many interesting and ancient ruins, the origin of which has so puzzled the archæologist. From the Zambesi River the line will pass to the great Lake Tanganyika, through country which is still in a great degree *terra incognita* but which, thanks to the splendid impulse given by Mr.

ANCIENT RUINS IN RHODESIA.

Rhodes, is rapidly being opened up to trade. The line will pass to the east of Lake Bangweolo, through magnificent country, good for cattle and especially productive of india-rubber, which is indigenous. Minerals, such as copper, are known to exist in this region. As far as possible all swamps and low-lying districts where fever is prevalent will be avoided.

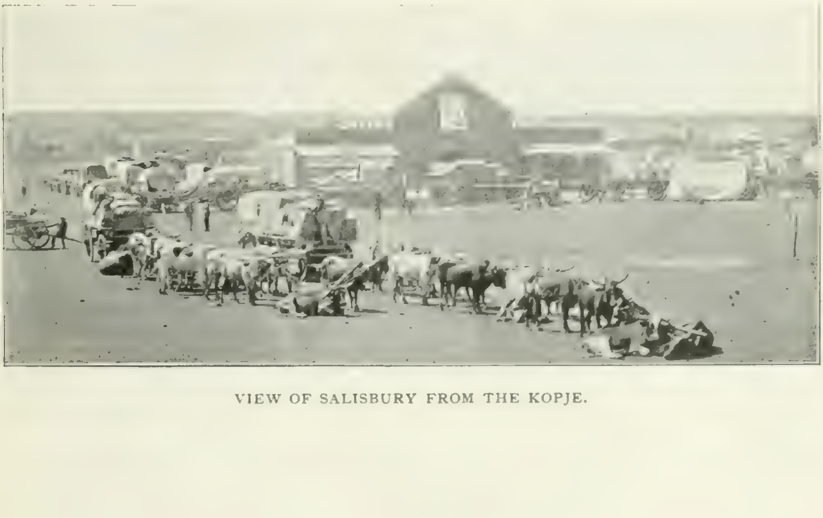
Some interesting and graphic details of the Ruanda country, between Lakes Victoria and Tanganyika, are given by Mr. E. S. Grogan, who recently returned thence, and who is probably the first white man who has travelled through Africa from the Cape to Cairo. Mr. Grogan found many active volcanoes in this region, one of which had existed for only two years, and which covered an area of between thirty and forty miles. Though there was no water in this country—the ground being too porous—it was very densely populated, the natives tapping water from the banana palms. Lava streams abound; and the whole country is overrun by a nomadic tribe of cannibals.

A WAR DANCE.

Dr. Emil Holub, the African explorer and scientist, in discussing the proposed route with the *Morning Post* interviewer last year, said it appeared to him that Mr. Rhodes did not take the conditions of climate sufficiently into consideration. The Marotse country should be avoided. The Marotses were a fierce, warlike people and might give

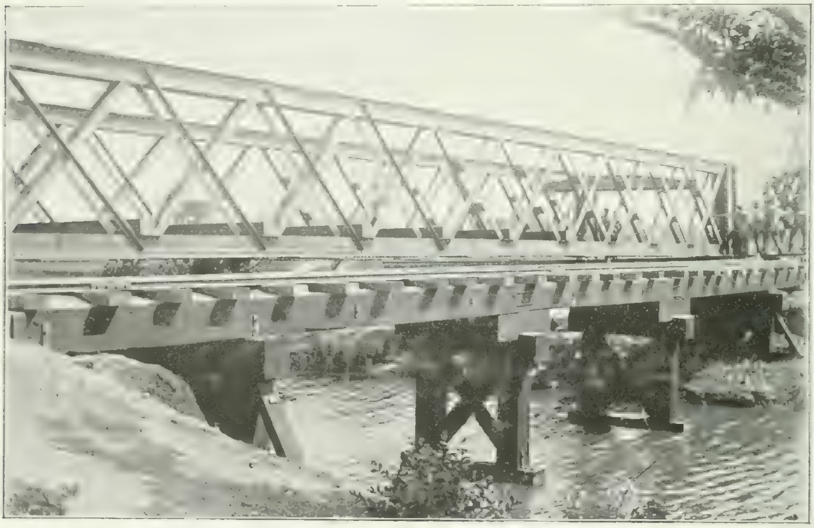
ROADSIDE STORE ABOUT 12 MILES FROM GWELO.

trouble. The natives died like flies of malaria in this country, whereas by edging further to the east, where the country was comparatively healthy, that would not be the case. On the other hand, the many rivers and the mountainous nature of the land had, no doubt, determined Mr. Rhodes, owing to the great difficulties of engineering, to abandon any attempt so far to the east. Still, he thought that in the end it would prove the surest and most economical route to pursue. Dr. Holub added that neither the Beira railway from the east nor the Congo railway from the west could ever compete with Mr. Rhodes' great line, which must be in the future the great carrying route for Africa. "Trade would always by preference go to the Nile; the Nile was the great waterway to civilisation." Directly the Zambesi is crossed towards the north one begins to ascend to the crest of the watershed between the Zambesi and the Congo, which is "but little higher than the highest grassy ridge in the neighbourhood of Salisbury. From thence," says Stanley, "a gradual descent is made to reach the central depression of the Congo basin." Northwards of the

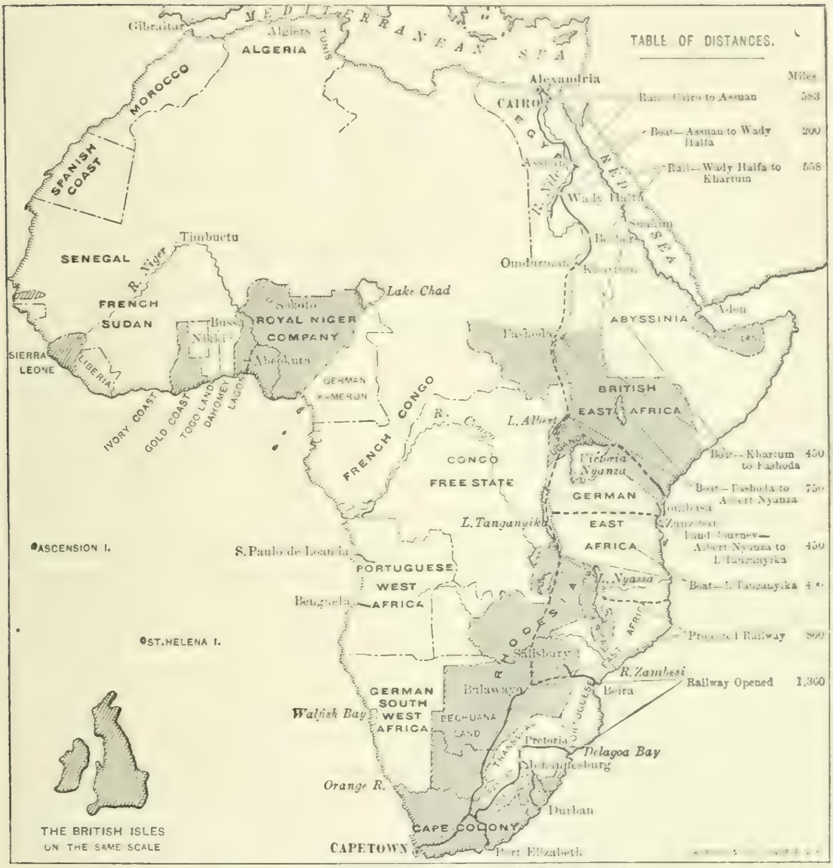


VIEW OF SALISBURY FROM THE KOPJE.

Congo watershed are again "the average altitudes of grassy ridges of South Africa," and then begins a descent into the basin of the Tchad Lake, and from thence to the Mediterranean the same system of great land waves, rolling and subsiding, continues. As to native labour, Mr. Rhodes should find no lack of it. He will probably get all he wants from Barotseland in Northern Rhodesia, the king of which country is said to be a somewhat enlightened monarch with a leaning towards the methods of civilisation. In German East Africa the line will probably pass through Tabora, and thus connect with the railway which it is proposed to construct from that town in an almost due easterly direction to the coast (Zanzibar). British territory is gained once more on the borders of Uganda, which is not so quiet a region as could be wished, but which is rapidly "settling down" under the firm sway of its new rulers. Here, the line will eventually connect with the railway now being constructed from Mombasa on the coast to the north of Zanzibar. Thanks to Lord Kitchener, whose splendid service to the Cape-Cairo scheme calls for the most generous recognition, Mr. Rhodes today has no Mahdi to fear—or to "square"—and the recent death of the Khalifa and the capture of Osman Digna have materially assisted in paving the way towards the realisation of the dreams of the Cape Colossus. Long before Mr. Rhodes' workmen, creeping up from the south, have reached the southern end of Lake Tanganyika,



LAUNCHING GIRDERS OVER THE KHAMI RIVER, A FEEDER OF THE ZAMBESI.
It is crossed near its head, about 15 miles southwest of Bulawayo.



ROUTE OF THE CAPE TO CAIRO RAILWAY.

the chances are that the workers from the north will have joined hands and metals with the German railway engineers on the southern border of Uganda. Before this, however, it is just possible that Menelik, of Abyssinia, who is reported to be a particularly wily individual, may have to be reckoned with—but Mr. Rhodes will doubtless be quite equal to the task. The Mahdi was admittedly too difficult a nut even for Mr. Rhodes to crack, but from Menelik no really serious opposition need be apprehended.

It is interesting to recall that the other day, when the railway had reached Bulawayo on the 20th parallel of south latitude, the railway from Cairo was at the Third Cataract, on the 20th parallel of north latitude. Since then the railway from the north has made very considerable progress, and one can now travel from Cairo to Khartum almost as easily and safely as from London to Brindisi. A few years ago it was pointed out by an authority in a letter to the *Times* that, in the old days when the Mahdi flourished, a journey to Lake Albert with arms and baggage, might be counted thus: Cairo via Suez to Suakim, steamer, six days; Suakim to Berber, camel, ten days; Berber to Redjaf, steamer, ten days; Redjaf to Kiri, boat, one day; Kiri to Dufli, road and porters, five days; Dufli to Kavalli, steamer, three days—in all thirty-five days, or five weeks, from Cairo to within sight of Stanley's Ruwenzori, the mystic Mountains of the Moon. It has taken thirty-eight years to construct the first link in the Cape-Cairo chain from Cape Town to Bulawayo—1,360 miles—but it will probably take considerably less than half that time to metal the remaining 4,000 or so miles from Bulawayo onwards. Indeed, Mr. Rhodes may very reasonably expect to live long enough to see the accomplishment of his great scheme. In twenty years' time, it is safe to prophesy, railway development in Africa will have made enormous strides—and the many important branch lines to connect with the Cape-Cairo trunk will have been constructed or be near completion. In the south the line from Johannesburg will have joined that at Bulawayo; Bulawayo, again, will be connected with a line running right across country to Walfisch Bay in German West Africa. In Central Africa, the trunk line will connect with German and British lines running to the east coast; and it is only reasonable to suppose that by that time a line or lines through Belgian territory will connect or be in close touch with the Cape-to-Cairo route. And that the trunk line will be a paying concern there is no reason to doubt. In the Rhodesian section already built the returns have advanced by leaps and bounds. For the first 13 months to October 31st, 1895, the net earnings amounted to £11,877; for the 12 months, ended October 31st, 1896, £38,043; for the 12 months, ended October 31st, 1897, £66,767, and for the 12 months, ended October, 1898, £99,290. These returns, it should be added, do not include the subsidies of £20,000 from the Imperial Government and £10,000 from the British South Africa Company. So far the profits have been utilised for the betterment of the line, but the time is not far distant when the shareholders will be pocketing handsome dividends. The engineering difficulties of the Cape-to-Cairo line are considerable, but not insuperable whilst labour is cheap and plentiful; so that, with Mr. Rhodes at the head to "push the thing along," there is every prospect of the scheme, vast as it is, being successfully accomplished, and that at no very distant date.

The Editor acknowledges the courtesy of the British South Africa Company in lending the photographs used in illustrating this article.

A COMPARISON OF THE ISTHMIAN CANAL PROJECTS.

By George A. Burt.

THE most important engineering problem in the world is the proposed piercing of the American Isthmus by an interoceanic canal. From the American side, the Nicaragua Canal Company has studied the facilities offered by the San Juan and Lake Nicaragua route, and has matured a project with many complications and unprecedented constructions necessitated by the topographical difficulties of its emplacement. The company failed to float securities and appealed to the United States Government to endorse bonds and otherwise go into partnership. Because of agitation in this direction, Congress had the Ludlow commission appointed to examine the route proposed by the company. In due course the commission reported in 1895 substantially that they believed the canal feasible at double the company's estimated cost, but they recommended extensive surveys, now in progress, to develop lacking information and establish more definitely the technical basis.

The French Panama canal, organized by de Lesseps in 1879 as a commercial company, floated securities for vast sums and began cutting a sea-level canal at Panama, winding up in 1889 out of funds. Since that time work and machinery has been well cared for and a considerable amount of excavation has been done on the summit cut, but in general the idea has been to maintain the *status quo* pending formation of a new company. In spite of the very substantial results accomplished by the French company at Panama, in the United States an interoceanic canal is supposed to mean only the Nicaragua canal. Little information exists regarding Panama—little more than a hazy and hugely mistaken idea that the canal has been abandoned as an impossible enterprise. The Atlantic termini of these two canals are about the same distance from New York, and about 300 miles apart.

It seems only too probable that, before this issue of THE ENGINEERING MAGAZINE appears, the United States will have committed the egregious folly of blindly endorsing the Nicaragua canal scheme, although every expert recommendation has been to the effect that such studies as the Walker commission are now concluding are absolutely essential to an intelligent judgment. If the Nicaragua route is the best, its advocates can fear nothing from the report of this commission. This comparative review is presented in hope that there may still be opportunity for sober sense to assert itself and await the evidence before giving the verdict. Since Mr. Burt's article was written, a new project is in existence for Panama, making many improvements in details. The Nicaragua plan may also be modified by recommendations of later commissions, but the general comparison is not materially affected. Further reference to the subject will be found on page 107.—THE EDITORS.

Each route is a little shorter for certain ports than the other, but for traffic as a whole it is evident that such difference in sailing distances can be of little moment. The whole decision, then, turns on the practical points of cheapness of cost and maintenance and flexibility of operation, and it is on these points that I propose to compare the two canal routes. It is, of course, necessary to compare canals of the same size in their wet cross sections, calculate quantities at the same price for similar materials, and in general compare on a uniform basis.

For the Nicaragua route the project estimated by the Ludlow commission is taken as a basis, involving:

Creation of harbors in two oceans;

Canal in excavation on both slopes ascending to summit level by four locks;

Damming the San Juan River at Ochoa by a rock-fill dam and converting it into slackwater and part of the summit level, at a minimum elevation of 110 feet above sea level.

For Panama, project of an artificial summit level formed by damming the Chagres River at Bohio to an elevation of 100 feet above the sea level, and descending to sea-level canal on either slope by a group of three locks.* This project has been thoroughly surveyed by the N. B. Wyse commission; additions have been made to conform it to the Nicaragua project.

Terminal Dams: The construction of these two canals is peculiar in the respect that both are dependent upon the feasibility of constructing rock-fill dams of great magnitude. Dams are to be formed by dumping large rocks from cableways, allowing the stream to scour between, to distribute them, and to settle them to a firm bed in the sand and clay beneath. The voids between the large stone are, at the same time, filled with smaller stone, and these voids in time are to become sealed by sand and clay. Back of the rock fill is to be dumped a heavy bank of clay. These dams are to be subjected to the flow of their rivers during construction, but to be raised to such permanent height as never thereafter to act as weirs. The length of crest line is about the same, but the Nicaragua Ochoa dam is 62 feet between water levels and the Bohio 90 feet.* In both cases their bases are supposed to settle many feet below the river bottoms by the scouring action of the water. The Bohio dam is higher* than Ochoa, but has the advantage of having its side slopes on solid rock. At Ochoa they are clay, and extensive abutments must be made to prevent scour around the ends. At Bohio, rock hills surround the site, affording cheap quarries for stone, while at Ochoa it must be obtained fifteen miles away. The quantities at Bohio are larger, but the construction as a whole is cheaper, mainly by reason of the absence of necessity of devices for controlling floods during construction. The respective maximum floods estimated are 150,000 cu. ft. per second at Ochoa, and 70,000 ft. at Bohio. Whatever question there may be in regard to such dams, it is the same in either case; in spite of the greater height, the Bohio is certainly equal, if not superior, to Ochoa in conditions as a whole.

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* These points are materially modified and improved in the plan now presented by the *Comité Technique.* The Bohio dam is much lower, while a second dam at Alhajuela regulates the upper Chagres.—THE EDITORS.

Water Supply: At Nicaragua there is no question as to ample water, the trouble being that its excess flow in floods is difficult to keep within such limits as not to drown property around the lake front. At Panama the summit level of 35 square miles in area is much more restricted. The canal in excavation in the summit cut is 33 feet deep below the spillway elevation of 100 feet. There is, in consequence, 3 feet storage over the summit level to be exhausted before the regular 30 feet depth will be interfered with. The minimum low-water discharge of the Chagres River at Gamboa, some 14 miles above Bohio, has been measured for years and is equal to about 950 cubic feet per second. Five considerable streams enter in the 14 miles and I would assume that at Bohio there would be a minimum of not less than 1,100 cubic feet per second.

The area of the summit lake is 975,444,000 square feet. Storage 3 feet deep gives, therefore, 2,927,232,000 cubic feet. Water for one lockage 650 x 80 x 36 feet requires 1,872,000 cubic feet. Assuming that each vessel will require on average 1½ lockfuls for passage, this should be increased to 2,808,000 cubic feet. Evaporation ¼ inch per day over surface would amount to 20,327,000 cubic feet. The low-water flow of the Chagres River per day is 95,040,000 cubic feet. Assuming that the maximum traffic figured for Nicaragua should be an average—there would be:

Thirty-two vessels locked per day, requiring—	89,856,000 cubic feet
Evaporation, as above......................	20,327,000 cubic feet
Consumption of water per day..............	110,183,000 cubic feet
Against this there is low water supply........	95,040,000 cubic feet
To be supplied from storage per day.........	15,143,000 cubic feet

The storage between contours 97 and 100 is figured, as stated above, at 2,927,232,000 cu. ft., sufficient to meet the above deficiency for nearly 200 days with permanency of extreme low-water flow for that time. The above calculation neglects leakage; on the other hand, it assumes the absolutely Utopian supposition that thirty-two vessels would be an average daily transit, and the equally impossible condition that extreme low water could continue for that length of time. The small Pedro Miguel dam will be tight by construction, and the Bohio must be made so by thoroughly compacting the earth lining. There then remains to be considered the leakage past lock gates. This is an indefinite amount, but is not necessarily large. There is ample margin for this and all other contingencies. But it is obligatory to make the Bohio dam tight, as must also be done at Ochoa, for similar reasons. It is an easy matter, with some extra expense, to double or treble this storage by increasing the elevations of spillways and cutting the summit lower. Lateral canals extend from Bohio to the sea, to receive spillway discharges and side streams and keep them from the canal.

Culebra and the Chagres: It was formerly said that the sliding strata at Culebra and the regulation of the Chagres River were two things at Panama impossible of control. The sliding material at Culebra* is a bed of fine clay, very absorbent of water and plastic in that condition. It is nowhere more than 30 feet thick; 1,300,000 cubic yards will cover the whole deposit, and the removal of that quantity figures in the estimate. In the present project the Chagres is received into the lake and offers no difficulties. It is the same problem that must be met at Nicaragua, with a flood discharge there doubly as great, and with the controlling necessity that regulation must be so efficient as never to raise the level of Lake Nicaragua† more than 3 feet above the determined artificial level. At Panama the only limit to permissive rise would be that of convenience in locks and spillways.

Supporting Structures for Summit Level at Nicaragua: I find, in a cursory examination of the Ludlow report, mention of one hundred and thirty-two such structures in the form of locks, dams, weirs, sluiceways and embankments. The worst case is the San Francisco division, and for that the Ludlow report is here quoted: "The total number of embankments is no less than sixty-seven, with a total crest length of 6 miles. The largest of these is the San Francisco, with a crest length of 1.2 miles, an extreme height above the river of 85 feet. There are five others—from 1,040 feet, with greatest height of 60 feet, to 1,840 feet, with height of 79 feet. These heights are measured from the surface of ground and do not include foundations. Borings in the beds of the Danta and Nicholson sank through 30 feet of soft mud to clay. There are at least four of these dams that will have a height considerably over 100 feet."

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* It must not be forgotten that the proposed central-divide cut on the Nicaragua route is three miles long and has a maximum depth of 328 feet, and that borings have revealed "rock more or less decomposed" at great depths below the surface "which may crush and allow the sounder rock above to fall."—THE EDITORS.

† Prof. Heilprin has recently called attention to remarkable differences in various determinations of the level of Lake Nicaragua. He concludes that the level is inconstant, and the oscillations possibly connected with volcanic disturbance to which the region is subject. Information on this vital point is sadly incomplete.—THE EDITORS.

There are to be clay banks built under a rainfall of 25 feet per annum yearly, and with material brought from a distance. Their construction offers enormous difficulties, and their maintenance is an equally grave question. The locks, spillways, and every form of construction have in nearly every case to be founded on clay. It cannot be denied that this condition is a very serious construction difficulty. Each one of these structures might be the place of damage from undercutting water, destroying the use of the canal for a long time.

At Panama there are two groups of structures to support the summit level.* These groups consist in each case of the terminal dam, the lock, and spillways. Everything is on rock foundation except the Bohio dam, and that is better situated than the Ochoa. There can be no question as to the greater relative simplicity of the technical problem at Panama.

Locks: At Nicaragua the locks are eight in number, at separate locations, with intermediate ponds. These locks require each vessel that passes the canal to make eight separate manœuvres of slowing down and warping in, with eight chances of fouling from misdirection and drift of the wind. At Panama six locks are grouped in two emplacements.* Only two entrance movements are required for a transit of the canal. It is self-evident that this is quicker, easier, and more advantageous in every way. The topography permits this grouping of locks at Panama, but it is impossible at Nicaragua. The objection is evident that with single-track locks the rapidity of lockage would be cut down two-thirds, with locks grouped together, when ships are ready to ascend and descend at the same time. This is met at Panama by making *all* locks doubled, so that the capacity of the canal is increased to passing a ship up and down through each lock at the same time, and the estimate of canal cost includes these double locks. The reason why the six double locks do not estimate very much more than eight single locks at Nicaragua is because:

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* On the "mean-level dividing-lock system" now proposed these details are altered; the Panama canal is to have eight locks, grouped so as to require five entrance movements. The locks are still doubled.—THE EDITORS.

1st. Doubling adds only 50 per cent., roughly, to the masonry.

2nd. There are six structures against eight.

3rd. Clay foundations at Nicaragua require iron and concrete floors, and, finally, the total lift is 10 per cent. greater at Nicaragua.

As any accident to any lock would block the canal, it seems to me that, if any traffic is to be done, it is a necessary and obvious precaution to have each lock doubled—and that for a fair comparison the Nicaragua estimate should be increased to provide for double locks throughout.

LENGTH OF ROUTE AND TIME OF TRANSIT.

The Panama route is 46 miles from ocean to ocean, against 174 miles for Nicaragua. Of this transit, 29 miles at Panama and 49 at Nicaragua are in excavated channel requiring slow speed and careful navigation. In addition, careful navigation will be required through 83 miles of San Juan slackwater and dredged lake channel at Nicaragua, and through 17 miles of the summit lake at Panama. The latter is much freer navigation than the former, but it must not be forgotten that the distance must be made through a buoyed channel more or less sinuous. The detention from lockage will be much less at Panama, both because the locks are fewer, and because there is less loss of time by reason of taking three lifts in sequence.

TIME AT NICARAGUA.

49 miles, at 5 miles per hour	9.80 hours
83 miles, at 7 miles per hour	11.85 hours
42 miles, at 15 miles per hour	2.80 hours
8 lockages at 45 minutes	6.00 hours
Total	30.45 hours

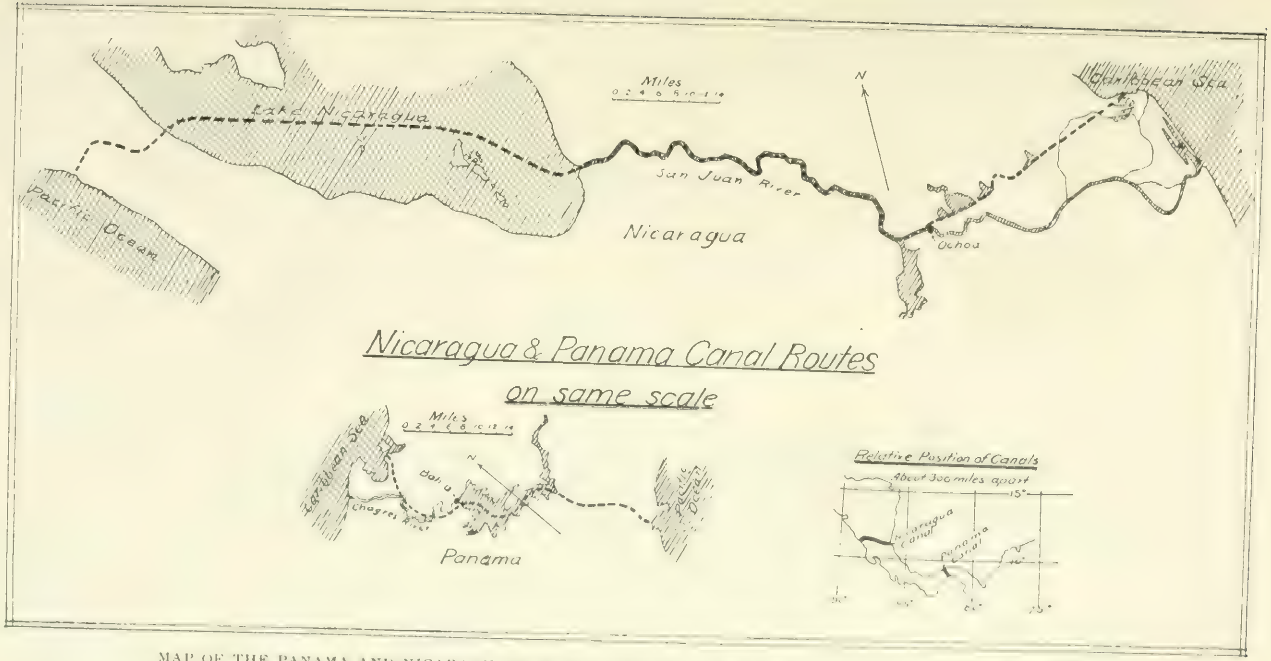
TIME AT PANAMA.

29 miles, at 5 miles per hour	5.80 hours
17 miles, at 7 miles per hour	2.43 hours
6 lockages at 35 minutes	3.50 hours
Total	11.73 hours

or a difference for steamers of nearly 19 hours in favor of Panama. The difference of towing time for sailers would be 28 hours.

COMPARATIVE COST.

The several classes of work are given for Nicaragua canal as found in the Ludlow report. At Panama there are only three classes of material—solid rock (mainly in lock foundations), dredgeable material



MAP OF THE PANAMA AND NICARAGUA CANALS ON THE SAME SCALE, SHOWING COMPARATIVE LENGTH.

in sea-level sections, and clays in the summit cut. These clays are not uniform in character, but all are of a type moveable by steam shovel without blasting. The lock estimate at Panama is the Wyse estimate, with prices somewhat higher per unit than used at Nicaragua. The railroad cost at Panama is for a change of line of the Panama Railroad, necessary to replace that portion to be submerged by the summit lake. No harbor-protection works are figured at Panama, because, with what has been done at Colon and the natural conditions in Panama Bay, none are needed. No rock protection for embankments is needed at Panama because there are no embankments; for revetting canal slopes, the figure used by the Ludlow commission for Nicaragua is also used for Panama. For engineering, hospital service, and buoys and lights, one-half of the Nicaragua estimate is used at Panama as a fair comparative allowance—there is only about one-half the work and the line is only about one-fourth as long. The Panama canal has been worked over from end to end, and there is in consequence no estimate for clearing and grubbing.

QUANTITIES AND COST OF EXCAVATION, BOTH CANALS.

Nicaragua.			Panama.	
Yardage	Value.	Per yard.	Yardage.	Value.
12,300,000	$2,460,000	$ .20	5,950,000	$ 1,190,000
33,228,500	8,307,125	.25	20,300,000	5,075,000
10,596,191	3,178,857	.30	....	....
13,277,508	5,311,003	.40	....	....
7,166,060	3,224,727	.45	....	....
1,574,729	787,365	.50	....	....
12,742,962	7,445,777	.60	29,650,000	17,790,000
875,229	612,660	.70	....	....
13,618	13,618	1.00	....	....
7,593,735	9,492,169	1.25	....	....
1,092,978	1,639,467	1.50	....	....
8,340,393	14,595,688	1.75	3,524,000	6,167,000
2,389,723	11,948,615	5.00	....	....
111,191,626	$69,217,071	Totals.	59,424,000	$30,222,000

ESTIMATE FOR DAMS.

Ochoa.			Bohio.	
Cableways	$ 150,000	...	Cableways	$ 150,000
Sheet Piling...........	100,000	...	Sheet Piling	100,000
Abutments	550,000	...		
600,000 c. y. Earth......	300,000	$.50	1,000,000 c. y. Earth..	500,000
2,000,000 c. y. Rock.....	1,400,000	.70	2,500,000 c. y. Rock..	1,750,000
River Sluices, etc......	1,500,000	...		
	$4,000,000	Totals.		$2,500,000

GENERAL COMPARATIVE ESTIMATE FOR COST.

	Nicaragua.	Panama.
Clearing and Grubbing	$ 350,150	....
Railroads and Telegraph	4,410,000	$ 2,400,000
Excavation	69,217,071	30,222,000
Terminal Dams	4,000,000	2,500,000
Locks	13,887,414	15,400,000
Sluices and Control Works	7,483,392	4,500,000
Rip-rap on Embankments	1,346,557	....
Rip-rap on Canal Slopes	498,116	498,116
Harbor Piers, Breakwaters, etc	4,534,710	....
Engineering	4,000,000	2,000,000
Hospital Expense	1,000,000	500,000
Lights and Buoys	500,000	250,000
	$111,227,410	$58,270,116
Add 20 per cent for Contingencies	22,248,482	11,654,023
Comparative Cost	$133,472,892	$69,924,139

The sea-level portions of the two canals will suffer to about the same extent from sloughing and wave action, to be easily repaired by dredging. Where the canal is in cuts rising above the water level, each hollow may be expected to contribute its stream, bringing down deposits and forming bars. There may be expected also land-slips, and an adequate equipment must be maintained to keep the channel clear. What maintenance expenses may amount to under the tremendous rainfall no one can form any idea. In a sea-level canal, such as Suez, in sand and with small current and 1½ inches annual rainfall, the operating expense for 1890 was about $1,500,000. Our two canals ought to be run for about equal management expense—but Panama would be cheaper in pilots, lights, and presumably in dredging and cleaning operations—certainly in proportion of canal excavation, or as about 29 to 49, and this difference may be a very large sum.

At Panama the transit is quicker, maintenance and operation probably much cheaper, construction difficulties less, and, finally, its cost will be only about one-half that of the Nicaragua canal.

Panama has harbors, wharves, machine shops, an interoceanic railroad, and organized transportation by land and sea. All these have to be created at Nicaragua to commence work properly.

The Panama line is cleared from end to end, worked over, with rails, locomotives, cars, hospitals and houses on the ground, much of it in good condition and ready to work with. At Nicaragua, a virgin forest and an abundance of swamps.

GAS ENGINES AND ELECTRIC STATIONS.

By Alton D. Adams.

ELECTRICAL-SUPPLY stations, deriving their entire income from the sale of the energy of coal, have a vital interest in the relation between the heat of combustion and the current at dynamo terminals. Steam-driven stations deliver, at best, but a small part of the heat from coal as electric energy, this being evident from a glance at the combined efficiency of the apparatus between the boiler, furnace, and distribution lines. Boilers of the best class, operated under favorable conditions, transfer into steam not more than 80 per cent. of the heat from the combustion of the coal. Compound condensing engines, at full and constant loads, transfer about 15 per cent. of the heat of steam into mechanical work at their shafts. Large dynamos, at nearly maximum loads, deliver, as electric currents, as much as 92 per cent. of the mechanical energy supplied to them. Combining these results, the dynamo current is shown to be but 80 × .15 × .92 = 11 per cent. of the energy liberated by the combustion of coal. This result, corresponding to a consumption of about 1.8 pounds of the best anthracite coal per electrical horse-power hour delivered at dynamo terminals, is very close to the best that is possible with electrical supply from steam power, and the great majority of stations are probably using twice the amount of coal named per unit of output. The large increase in the amount of coal used at electric stations, over that necessary with the best economy, is due chiefly to lack of full and uniform loads and to the rapid changes in the conditions of load during the day.

It has been well known for several years that gas engines transform into mechanical work a larger part of the heat energy entering their cylinders than do steam engines. The 15 per cent. efficiency above named for the steam engine is quite close to the best that can be attained with large units of the best class, while gas engines, in very moderate sizes, readily show an efficiency of 20 per cent., and in units of several hundred horse power, under favorable conditions, as high as 25 per cent. in delivered power. Until a recent date the gas engine, in spite of its comparatively high efficiency, has not been considered available for general use in large power plants, because of the heavy investment and wide space required for gas-generating plants, and more especially because the methods of gas production in common use yield such moderate portions of the heating power of the coal consumed.

The efficiency of 80 per cent. for steam boilers and 15 per cent. for steam engines shows a combined efficiency of 80 × .15 = 12 per cent. for the two, or a consumption per brake horse-power hour of (2545 ÷ (.12 × 13000)) = 1.63 pounds of anthracite coal yielding 13,000 heat units per pound, one horse-power hour being the equivalent of 2,545 heat units. Coal-gas contains 25 per cent. and water-gas 60 per cent. of the heat energy of coal used in production, coke and other valuable materials being a residual product of the coal-gas process, but that for water gas leaving nothing of utility. The combined efficiency of coal-gas apparatus and the gas engine is thus but 25 × .25 = 6.25 per cent. for power production alone, and the efficiency of water-gas plant and engine is 60 × .25 = 15 per cent. It seems evident, therefore, considering the cost of coal- and water-gas plants, that their erection purely for purposes of power production is of questionable advantage.

Development of a third variety of gas apparatus, which costs only a moderate sum per unit of capacity and produces gas with a materially larger part of the energy of the coal than the above, now puts the gas engine in direct competition with the steam engine for large power plants. Producer gas is now readily made to contain 80 per cent. of the heat energy of the coal consumed, and the cost of such producer apparatus exceeds by only a moderate per cent. that of first-class steam-boiler plant of equal horse-power capacity. With producers that deliver gas having 80 per cent. of the heat energy of the coal, and gas engines transforming 25 per cent. of the heat from gas combustion into mechanical work, the efficiency of the combination is 80 × .25 = 20 per cent. With 13,000 heat units per pound of coal, this efficiency corresponds to a consumption of (2545 ÷ .20) ÷ 13000 = .98 pound per horse-power hour, instead of 1.63 pounds, as in the best steam-power plants. An electric plant driven by gas engines, operated by producer gas, is thus able to deliver at dynamo terminals 80 × .25 × .92 = 18.4 per cent. of the energy of the consumed coal, against 11 per cent. in the steam-driven plant. The saving in the weight of fuel by the adoption of the producer-gas equipment amounts to (1.63 — .98) ÷ 1.63 = 39.4 per cent. of the coal required in the steam-driven station. This reduction in the total weight of coal for a given power development is not the only advantage as to fuel that lies with the gas plants. Producer gas is readily generated from grades of coal too fine for use in the ordinary boiler furnace, and consequently of a very low market price.

Certain features peculiar to the operation of electric stations render the gas-producer plant especially suited to their wants. The average load of electric stations usually ranges between one-fourth and one-half of the maximum load. A change from average to maximum load, or from maximum to average load, at an electric station, commonly occurs within one hour. Maximum load seldom continues more than two hours out of the twenty-four. To meet these conditions the steam-driven electric plant must usually have engines and boilers of much greater capacity than that necessary for the average load. Great variety of loads makes it practically impossible to keep all operating engines at work to their full capacity, as is necessary to insure high economy. For wide and rapid load changes, boilers must be under fire during a large amount of time when their service is not required; this condition reduces the total boiler efficiency. These characteristics of electric stations have made the use of storage batteries general. The storage battery absorbs energy during times of moderate load, delivers energy at periods of maximum and also of minimum loads, and serves to steady the station pressure for momentary fluctuations of the demand.

Storage batteries thus tend to reduce, but do not do away with, the disadvantages to which the steam operation of electric stations is subject. In the first place it is not usually thought to be desirable, nor is it the practice, to install batteries of such capacity as to make the steam-engine load constant, so that the percentage of idle engines and boilers during a large part of the day is only reduced, not eliminated. The time occupied in getting up steam and drawing fires, in comparison with the entire time that some boilers are in use, is still too great for the best economy. Battery capacity is more expensive than engine capacity; all of the energy delivered by batteries must of course be first supplied to them by engines and dynamos, and the battery must waste some energy, as it cannot possibly return all that is sent into it. In spite of these disadvantages, these storage batteries have proved to be the best adjuncts thus far discovered for steam-driven electric stations.

Where gas producers and engines are substituted for steam engines and boilers, in electric plants, the conditions of load peculiar to electrical supply can be more economically met. Considering first the steam boiler and the gas producer, their comparative adaptation for varying and widely different loads should be noted. Steam from a boiler under regular work is used as fast as generated, the supply in the boiler at any instant being usually less than is required per minute. Even the water in a boiler contains comparatively little heat, as will be at once evident if the furnace fire is drawn and the engines kept at full load, while an eye is had to the pressure gauge. The same fact is readily shown by calculation, since, taking the temperature of boiler feed water at 212° F., and the boiler pressure at 150 pounds by the gauge, the heat units per pound of water at the maximum temperature corresponding to this pressure are 157.5 above the heat in the feed water, while the heat units above the feed per pound of steam are 1012.6, or more than six times as many, the latent heat of steam at 150 pounds gauge pressure being 1012.6 — 157.5 = 855.1 heat units. The water in a boiler, therefore, contains less than one-sixth of the heat necessary to convert the water into steam. The regular tubular boiler, with a full supply of water, contains the amount necessary for work at rated capacity during from four to five hours, but the heat in this water above 212° F. is only about equal to that given off by the boiler in steam during 4.5 ÷ 6 = .75 hour. In water-tube boilers the energy in the contained water usually bears a smaller ratio to the boiler capacity per hour than that just shown. It is thus quite evident that the steam boiler can only act as a reservoir of stored energy to a small extent, so far as the varying loads of electric stations are concerned. Some effort has been made to store energy at electric stations during times of light loads by hot water in heat-insulated tanks, but this system has not met with much favor. Any plan to store energy in hot water or steam labors under the great disadvantage that the capacity for work in these substances is present in the active form of heat, which constantly tends to escape, while the energy of the storage battery, like that in coal, is only set free by chemical action, and is thus readily retained until such action is permitted.

Producer gas, like the other varieties, has a capacity to do work, not because of the free energy in it, but only on combustion. Gas may, therefore, be stored for an indefinite period with no material loss of energy, and used either slowly or rapidly, as desired. It follows at once that the capacity of gas producers for an electric plant need correspond only to its average daily requirement, and is much below the rate of gas consumption at times of maximum load. Gas producers for an electric-supply station may thus be operated regularly at the most advantageous rate, and not forced in and out of service to meet the varying exigencies of public demands, as are steam boilers. As a station load rises rapidly, near the period of its maximum, it is only necessary to start the proper gas engines and their dynamos, without changing in the least the conditions of work at producers.

With a gas receiver of moderate capacity for an electric station, no question like that of constant steam pressure at boilers during times of hardest work has to be considered, as the supply of gas to the engines goes on at the same pressure whatever the number at work or their stage of load. The drop from maximum load, which in electric stations is as rapid as the rise, does not involve with gas producers the disadvantages incident to steam boilers quickly put out of service. As only the gas engine and dynamo capacity must correspond with the maximum machinery output of an electric station with gas producers, the burden of investment, for the brief periods of maximum load, is not so heavy as with steam plants, where boiler equipment must increase with the engines. In an electric station equipped with gas plant, the gas receiver fills, in large measure, the purpose of a storage battery, so far as concerns the accumulation of surplus work at one time and its delivery at another. A result is that in stations with the gas equipment the desirable battery capacity, in relation to total output, is much reduced. Smoke prevention in most steam-driven electric plants remains in practice an unsolved problem, for which gas producers offer a sure and practicable remedy. Briefly, gas producers and engines have the following advantages over steam equipment for electric stations: Considering the best obtainable results, for each class of apparatus, the steam plant consumes (1.63 — .98) ÷ .98 = .66 per cent. more fuel than the gas equipment. The conditions of operation at electric stations do not permit the most economical performance of steam plant, but have a much smaller influence on the efficiency of gas equipment. Not only the amount of coal, but also its necessary quality and price, are reduced by the adoption of gas producers and engines. The gas receiver renders storage batteries unnecessary, except for pressure regulation, and thus greatly reduces the cost of battery plant and the energy lost in its double transformations.

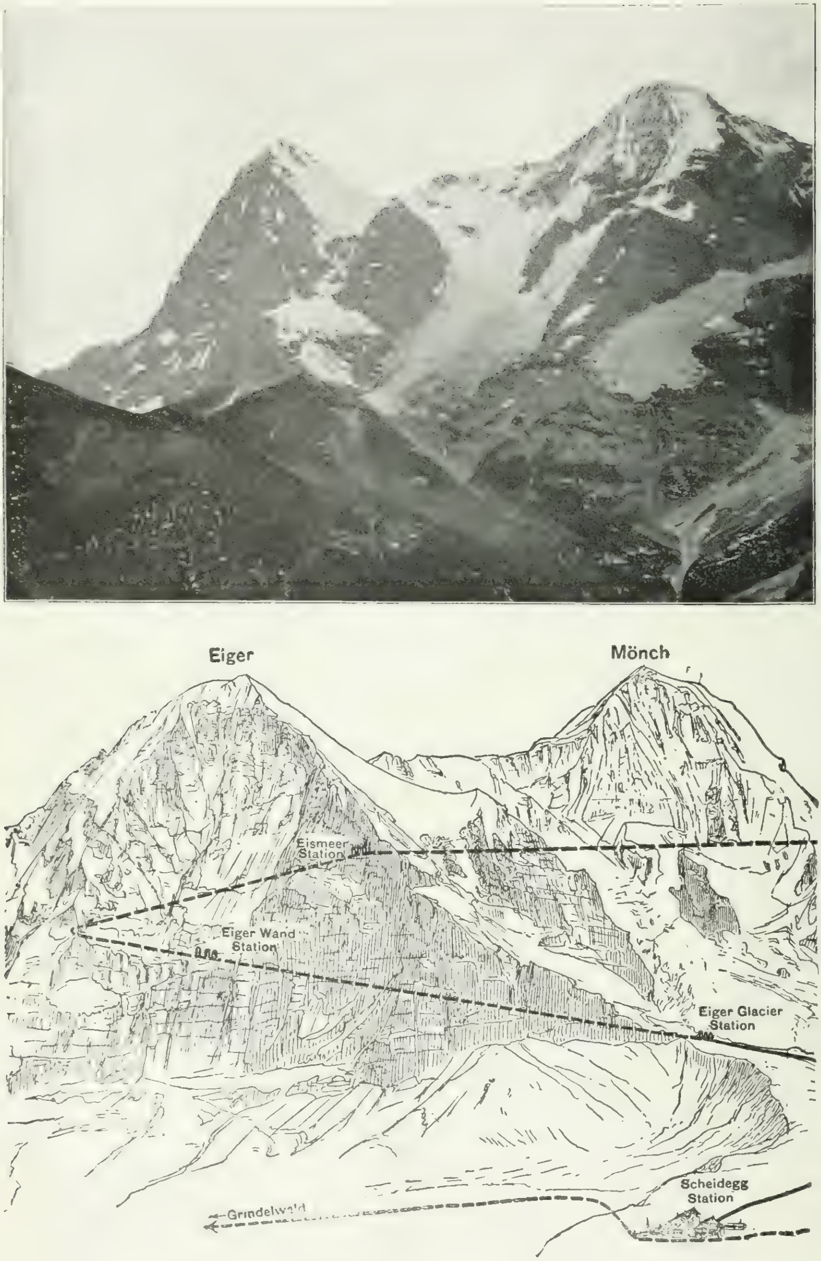
THE JUNGFRAU THREE-PHASE ELECTRIC RAILWAY.

By Ernest Kilburn Scott.

WHEN the Swiss Federal Council was asked to grant a concession for building a railway to the summit of the Jungfrau, most people received the announcement with a considerable amount of scepticism. Long study on the spot by engineers accustomed to mountain railways showed, however, that, with the help of electric power all the difficulties could be surmounted at a reasonable cost. The late Mr. Guyer-Zeller, of Zürich, commenced studying the question in 1890, and, having satisfied himself that the line could be built from Scheidegg with a maximum gradient of 25 per cent., and that it was possible to bore in solid rock across the neck of the Jungfrau, he obtained the concession in December, 1894. A sum of 30,000 francs was placed at his disposal by the railway commission for the purpose of awarding a premium for the best scheme, stipulation being made that the maximum gauge should be 1 metre, length of tunnel 10 kilimetres, minimum radius of curvature 100 metres, and the speed 7 to 10 kilometres per hour. It was further decided to work the line electrically, by water, from one of the neighbouring rivers.

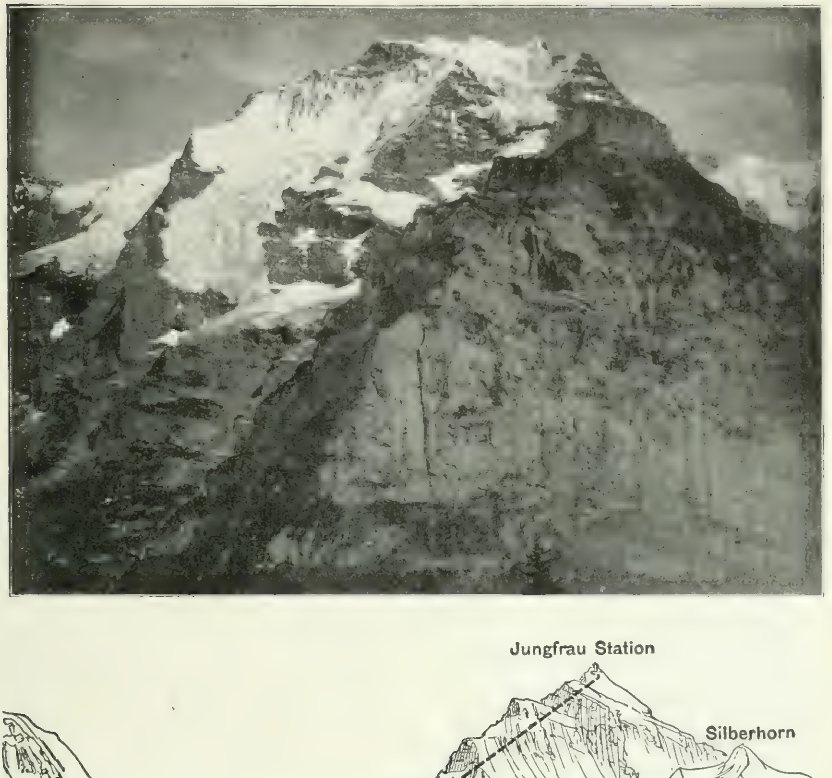
In August, 1896, after having considered the various memorials and selected six of the most favourable, the commission settled the line of railway and rail laying was commenced.

The problem then presented itself whether continuous or three-phase motors should be used on the locomotives. It was evident, having regard to the great distance which separated the generating station from the transformer stations, that it would be necessary to transmit the electric power primarily by alternating currents at high tension and transform down by static transformers and rotary converters to continuous current, or by static transformers only, using three-phase motors on the locomotive. Messrs. Wüst-Kunz (an electrical engineer of Seebach) and Thormann (of the Oerlikon staff), were asked to study the problem and draw up comparative estimates. They found that in the first case, where the three-phase currents are transformed into continuous currents, the cost of the installation came out at £38,000, whereas, by the exclusive employment of three-phase currents, the cost would be only £25,000. It was therefore decided to adopt this latter method.



PANORAMA OF THE JUNGFRAU RANGE.

The cut below furnishes a key to the upper engraving. The extension of the range and the road appear on page 35, facing.



CONTINUATION OF THE VIEW OPPOSITE. THE JUNGFRAU PEAK.

The lower view, from a slightly different point, shows less foreshortening of the stretch between the Mönch and the Jungfrau.

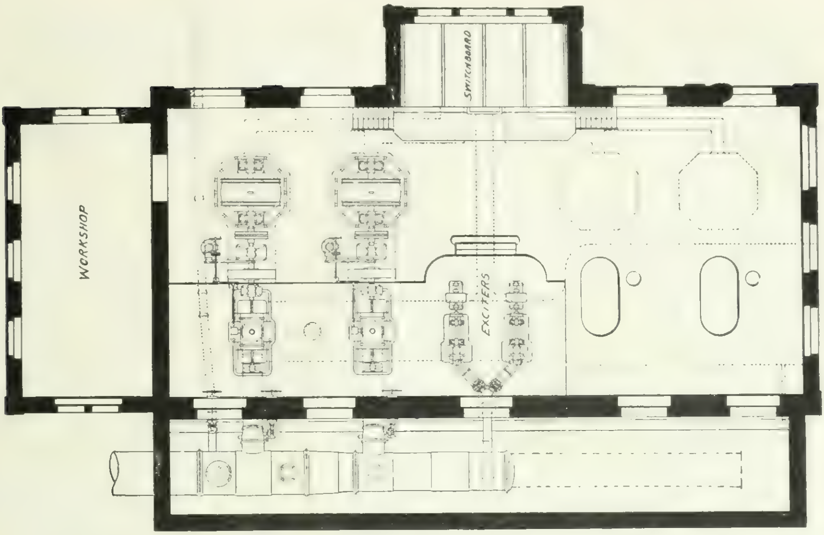
In September, 1898, the first section was opened, whilst the tunnel, which was commenced about a year earlier, has now been pushed forward to the Eiger station, which, as will be seen from the following table, is fourth on the list:

Sub-Station.	Name.	Distance between Stations.	Above Sea Level.	Total Distance from Scheidegg.
		Metres.	Metres.	Metres.
1	Scheidegg.................	2 000	2,064	....
2	Eigergletscher	....	2,321	2,020
3	Gorge...	950	....	2,950
4	Eiger	1,000	3,270	3,950
5	....	950	....	4,900
6	Eismeer.....	940	. ...	5,840
7	....	1,000	....	6,840
8	....	1,000	....	7,840
9	Jungfrau Joch.....	1,000	3,393	8,840
10	....	1,090	....	9.930
11	....	1,090	....	11,020
12	Jungfrau Kulm.......	1,080	4,166	12 100

There are twelve transformer stations for the complete line, the last being reserved exclusively for controlling the lift. The presence of these numerous transformer sub-stations assures to the working of the line much greater security than a small number of larger stations, because, in the latter case, should one station fail to act on account of an accident, the train service would most probably be brought to a standstill. The two first sub-stations are in the open, and are constructed of solid masonry, to withstand the action of the weather. The remainder are in the tunnel and consist of transverse galleries abutting on a large opening, from which tourists can admire the panorama. The question of slips and avalanches has been carefully considered before fixing the position of these windows, so that there will be no danger to travellers.

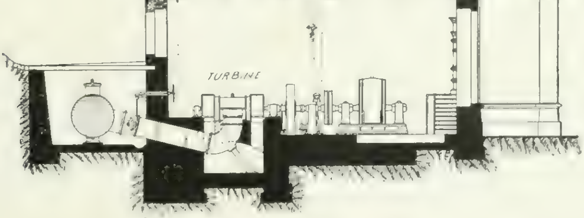
When the line is completed there will be two power stations—one of 2,300 horse power, on the White Lutschine, at Lauterbrunnen, which is already at work, and the other (the Burglanen station), on the Black Lutschine, near Grindelwald. This latter station, which has yet to be built, will have an output of 2,600 horse power.

The water for the generating station at Lauterbrunnen is tapped from the White Lutschine, immediately above the bridge of the Wengern Alp Railway, where a dam and basin for getting rid of gravel have been built. After passing the gates the water enters a steel pipe line, 1.8 metres internal diameter and constructed of rivetted sections. The first, or buried part, of the conduit is nearly horizontal, 690



PLAN OF POWER STATION ON THE WHITE LUTSCHINE, AT LAUTERBRUNNEN.

metres long and in sections of 6 metres each and 5 millimetres thick. The second and lower conduit is 625 metres long, in sections 7.35 metres each and 6 millimetres and 7 millimetres thick; being in the open, it is provided with expanding joints. A large-section vertical pipe forms the junction of the upper with the lower conduit and serves to avoid shocks and ensure a smooth flow of water.



SECTION THROUGH LAUTERBRUNNEN POWER HOUSE.

Between the dam and the turbines the difference in water level is 40.8 metres, but, allowing for friction, loss, etc., the really useful head may be reckoned at 35.5 metres.

The turbines, by Messrs. J. J. Rieter & Co., are six in number, of the twin Gerard type, with axial flow and automatic regulation.

	One Main Turbine.	Three Main Turbines.	Two Exciter Turbines.
Effective fall in metres..................	35.50	35.50	35.50
Volume of water in litres per second....	2250	1430	72
Horse power,..........................	800	500	25
Number of revolutions per minute........	380	380	700

The alternators, by the Oerlikon Co., are of the inductor type—that is, with the stationary armature and field coils. They generate at a pressure of 7,000 volts, the frequency of the current being 38 periods per second. The armature windings are divided into two equal parts, disposed on either side of the inductor bobbin. The movable part is composed of cast steel, carrying a series of laminated poles.

The alternators are insulated from the ground by porcelain insulators, Rafford flexible couplings serving to insulate the alternator shaft from the turbine.

Each of the two exciters is capable of producing 150 amperes at 120 volts when running at 600 revolutions per minute, the two machines together being sufficient for the four alternators. Experience

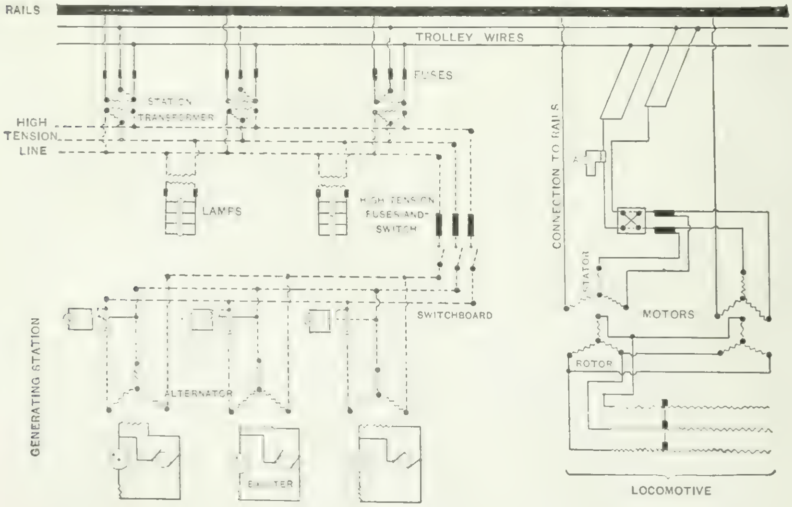
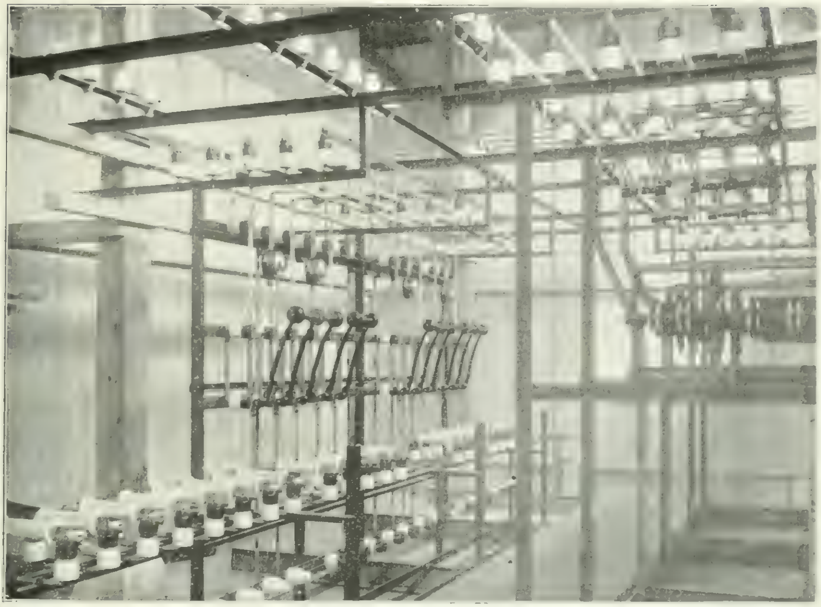


DIAGRAM OF SUB-STATION ARRANGEMENT, SHOWING SWITCHBOARD CONNECTIONS.



THE BACK OF THE SWITCHBOARD, LAUTERBRUNNEN STATION.

has shown that in hydraulic stations, where the load is very variable, it is better to have separately driven exciters. Rheostats are provided in the shunt circuit of each exciter, and also in each alternator.

The alternator circuits are star connected, whilst the sub-station transformers are in delta. The fittings on the switchboard are arranged as shown in the diagram of connections. A feature of the switchboard arrangement is that all the dangerous work is situated in a room at the back. The high-tension fuses consist of wires run in porcelain tubes, open at the ends and lined with fire-clay. The total expense of the generating station, including buildings, dam, pipe line, generating plant, etc., works out at about £11 per horse power of plant installed, which, considering the situation, is a low figure.

The road is formed from end to end of steel rails fixed on iron sleepers. The normal length of each rail is 10.5 metres, or exactly three times the length of the rack sections. The height of the rails is 100 millimetres, and the weight per metre run is 20.6 kilogrammes. The junction of the rails is effected by means of square fishplates, notched on each side to grip the chairs; the ends of the rails are cut to 45 degrees, in order to secure as smooth running as possible. Each joint has two Chicago bonds of 7 millimetres diameter, and the rails are cross-connected by copper wire 8 millimetres in diameter.

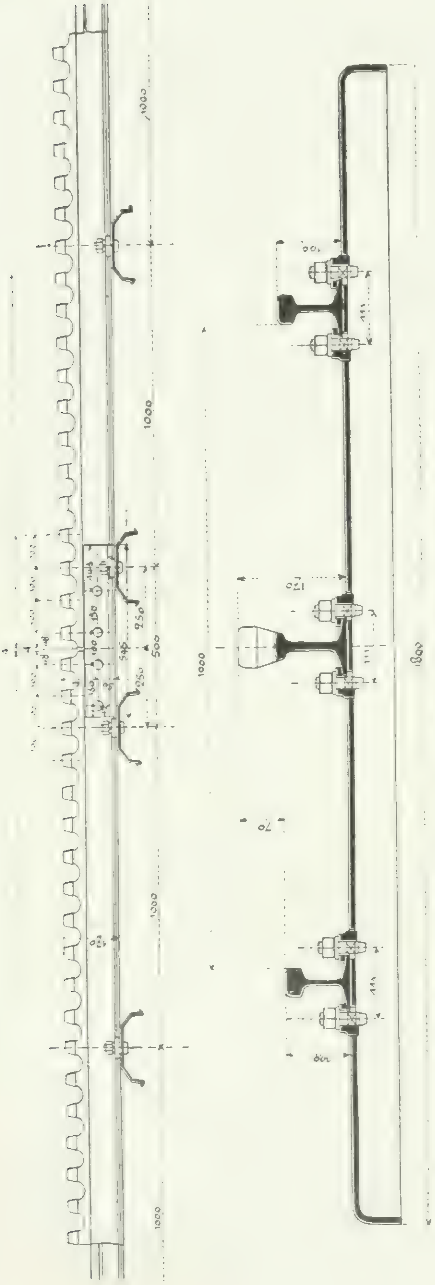
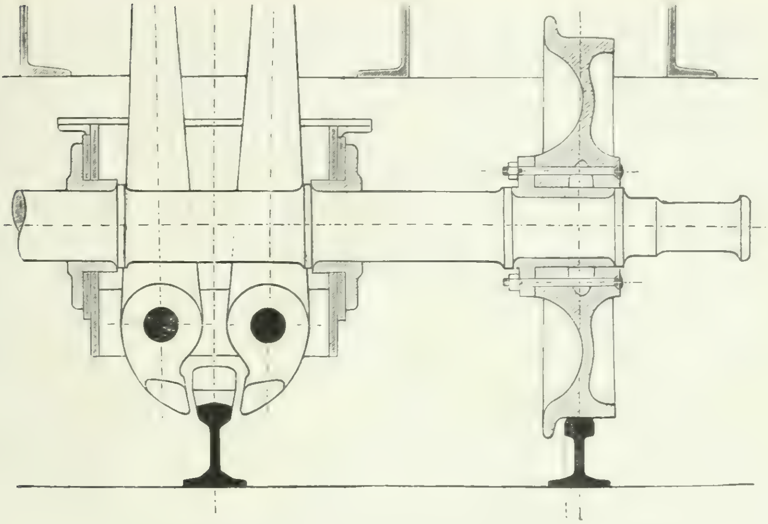


DIAGRAM OF RAIL JOINT AND SECTION OF PERMANENT WAY.

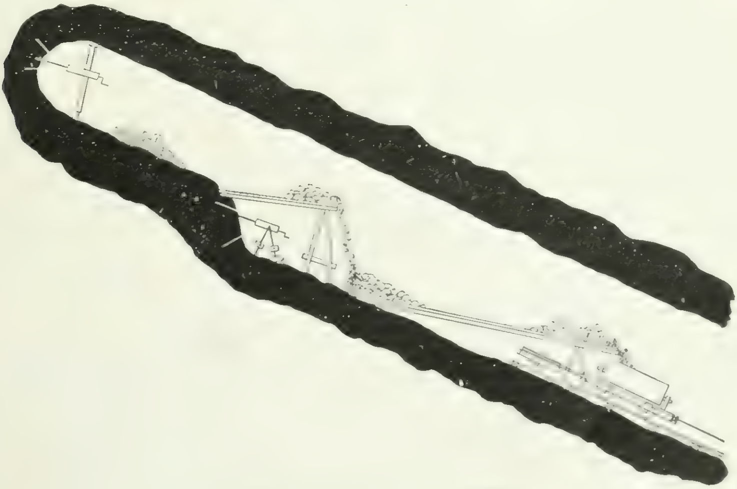
The rack is of "Strub" sections, with a broad head, permitting the employment of clamps to prevent rising of the locomotive. It was at first intended that these clamps should also serve as safety brakes, but this has been found impracticable. The material of the rack has a tensile strength of 45 kilogrammes per square millimetre, with an elongation of 20 per cent. The weight is only 34 kilogrammes per metre run; the complete track, with sleepers, fish plate, etc., weighing 130 kilogrammes per metre. The teeth of the rack are cut from the solid steel in the following manner: Two one-inch holes are first drilled at the bottom of the tooth space, and the metal is then sawed out, the saw working at the requisite angle. Afterwards the wedge-shaped bottom of the tooth space is milled out and the rail is cut off to the exact length and the holes for the fish plates drilled.

The tunnel is being pierced through a calcareous rock, which is remarkably tenacious and solid and little affected by the atmosphere. It is a most advantageous kind of rock for the boring of a tunnel, be-



SECTION THROUGH RAIL AND RACK, SHOWING SAFETY CLAMPS.

cause of the facility with which it bursts under the action of explosives, besides which it is sufficiently firm not to require any covering of masonry. Of the ten kilometres, at least eight will be through this excellent material. The total expense of boring the tunnel is expected to be £200,000. The cut below shows the method, boring being



METHOD OF BORING THE TUNNEL.

carried on at two places, a low gallery being first formed, having the full width of the tunnel. At the face two electric drills pierce a series

THE ENTRANCE TO THE TUNNEL.

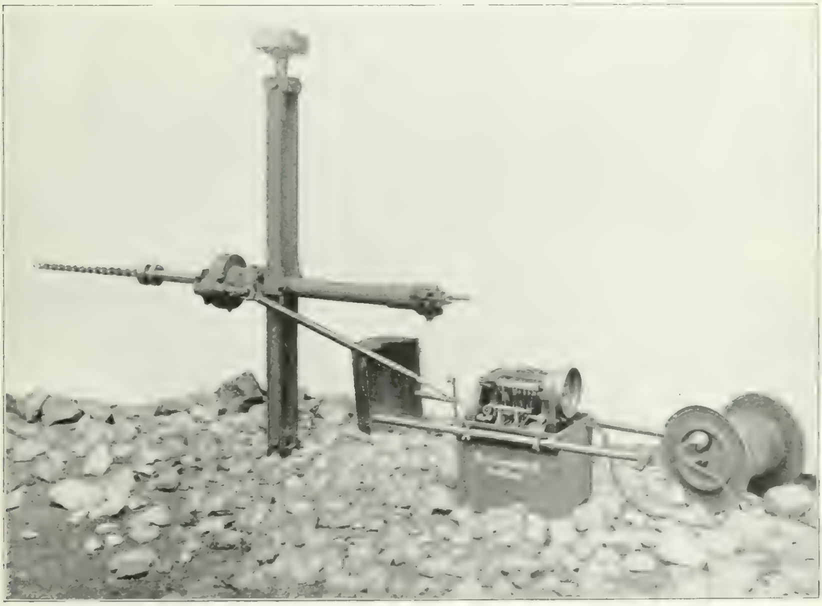
of holes, one metre deep, and when the cartridges have been placed in position the workmen retire to the nearest cross gallery. As the blasting operation can only take place about four times a day, the daily progress is, of course, limited to four metres. The débris passes into tipping wagons worked by an endless rope, and is emptied out at the nearest cross tunnel.

At the entrance to the gallery there is a temporary building containing two three-phase 200-kilowatt transformers, reducing pressure from 7,000 to 500 volts. The three-phase, low-tension currents thus obtained are used for driving the electric drills, working a ventilator to clear out the smoke after an explosion, and providing power to melt snow for the drills. The lighting of the tunnel is provided for by 16-candle power lamps at 25-metre intervals, the stations having 100 lamps of 16-candle power. The heating will be carried out by 10 radiators, each of 1 kilowatt capacity. When the tunnel reaches a height of above 3,000 metres, it is expected that difficulties will be encountered on account of mountain sickness. At present the majority of the workmen employed are Italians, but above 3,000 metres it is almost certain that they will have to be replaced by Swiss mountaineers. It may be mentioned that the sickness only attacks those engaged in fatiguing work. Tourists are not likely to be troubled with it.

There are two types of drill in use, one the rotary type, supplied by the Oerlikon Company, the other the percussion type, constructed by the Union Electricitäts Gesellschaft, of Berlin.

The rotary drills are mounted on a vertical carriage, provided at the top with a screw to fix it between the floor and ceiling. The drill is actuated by means of a small three-phase motor of 3 horse power. Water is provided to clear out the cuttings and to keep the tool cool. The following gives the results of a test, under working conditions:

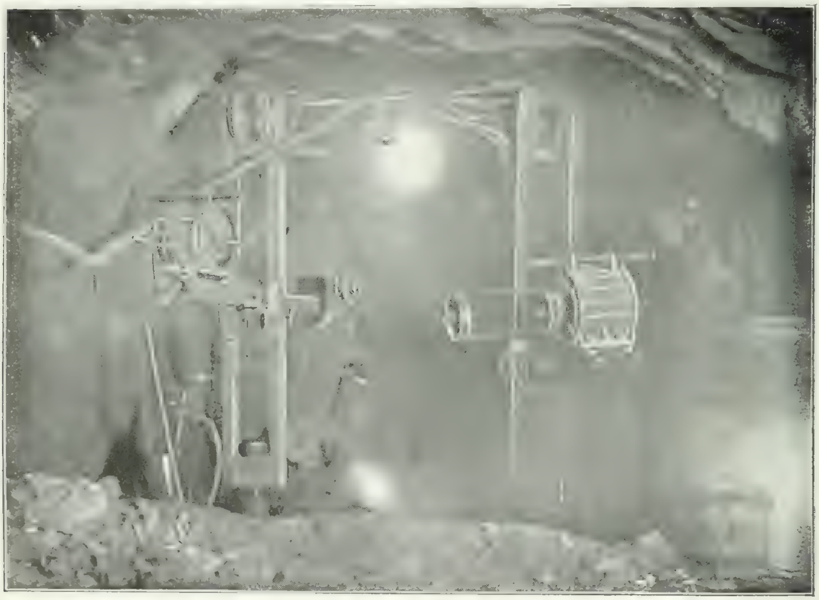
	Depth of hole, millimetres.	Time occupied in boring, minutes.	Amperes.	Volts.	Number of revolutions of motor per minute.	Number of revolutions of drill per minute.
1	700	8.5	6.0-7.5	220-230	1040	37
2	950	13.5	5.0-9.5	210-215	1060	36
3	550	10	5.5-8.5	215-227	960	33
4	350	6	6.5-7.5	217-220	960	33



ROTARY DRILL, OPERATED BY 3 HORSE-POWER THREE-PHASE MOTOR.

The percussion drill is worked by pulsating currents, and consists of two solenoids enclosed in an iron cylinder carrying the rotating mechanism of the drill. Within these solenoids there is a core of soft steel, one extremity working inside the rotating mechanism and the other extremity carrying the drill. As the current is sent alternately into the bobbins the core reciprocates backwards and forwards.

A three-phase motor drives the special generator, producing pulsating currents at 200 volts. This generator consists of a continuous-current four-pole dynamo, provided with an ordinary commutator for its own excitation, and also collector for sending the current alternately into one or other of the solenoids. As the generator revolves at 400 revolutions per minute, it follows that 400 strokes of the drill are made in the same space of time.

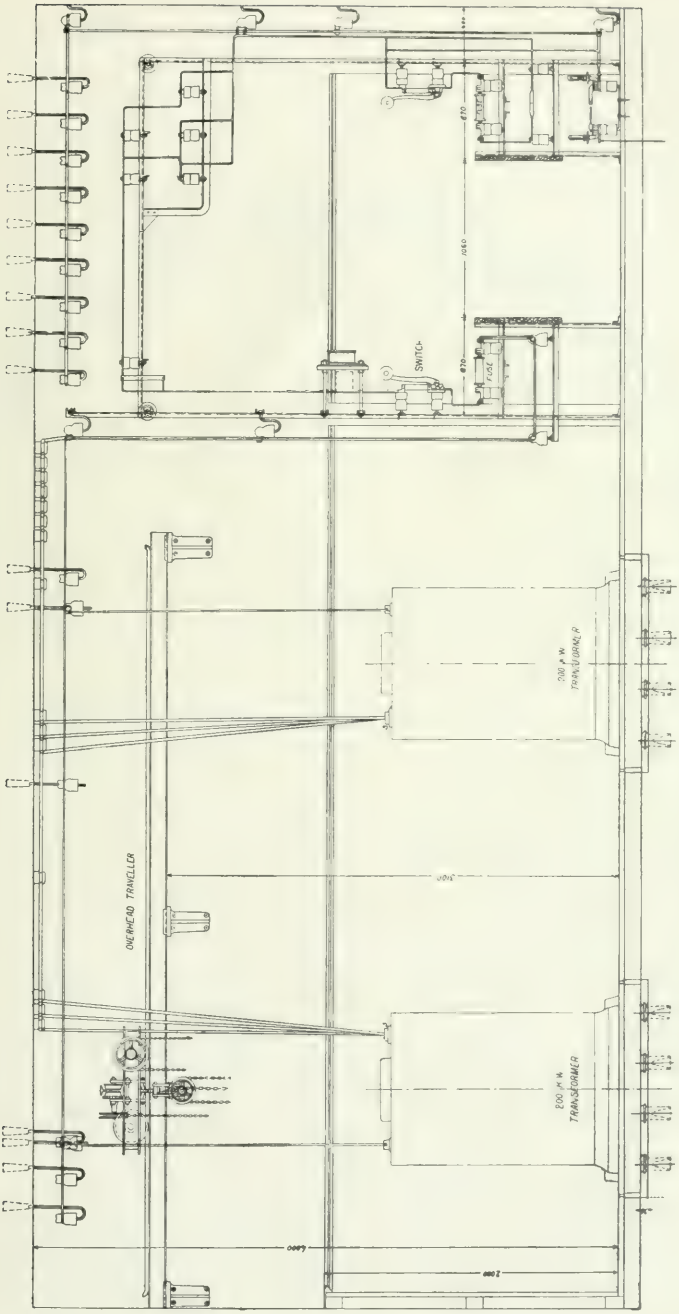


BORING MACHINES IN THE TUNNEL.

The following is the result of a test made by one of these drills:

	Depth obtained in ten minutes.	
Very hard granite	441	millimetres
Granite	458	"
Very compact slate	465	"
Ordinary slate	536	"
Slaty rock	752	"

Percussion drills give the best results and are most suitable for rocks of great hardness, which the auger drill will not touch. The



SECTIONAL PLAN OF SUB-STATION AT SCHEIDEGG.

solenoids have the disadvantage of heating excessively after a few hours' work.

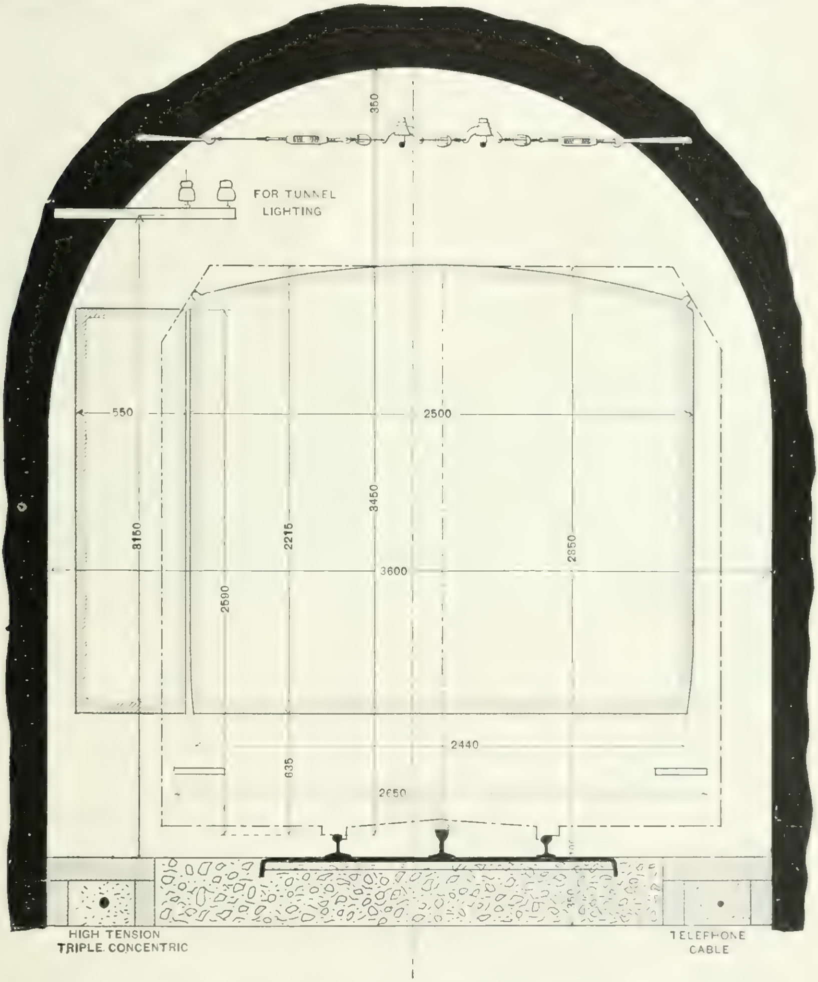
The transformer station at Scheidegg is the first of the sub-stations so far erected. It contains two 200-kilowatt transformers, with provision for a third. The sub-station at the Eiger glacier is similar. The three-phase transformers reduce the pressure from 7,000 to 550 volts, and are made by the Oerlikon Co. They have three cores, disposed vertically and connected top and bottom by cross strips of soft metal. The primary and secondary bobbins are wound on separate formers, and are then slipped over the cores, so that, by simply removing the upper yoke, which forms part of the protecting cover, a coil can easily be replaced. The complete apparatus is protected by expanded metal, thus allowing the bobbins to be clearly seen when at work. The substation in the tunnel has, besides the 200-kilowatt transformers, a separate room, in which is a 42-kilowatt transformer which transforms current down to 120 volts, the three secondary conductors being connected to a three-phase motor, direct coupled to a continuous-current dynamo. This motor-generator set is for supplying current to charge accumulators, these latter being necessary for lighting and heating the stations and houses when the generating plant has ceased to work.

The primary line from Lauterbrunnen to Jungfraukulm will cover a distance of about 22 kilometres, and is calculated for a loss of 10 per cent. The line is composed of three wires, of 7.5 millimetres diameter, of hard-drawn copper, mounted on triple petticoat porcelain insulators 4½ inches diameter by 7 inches high, on fir poles 10 metres high, impregnated with sulphate of copper.

The Lauterbrunnen-Scheidegg section is 6,500 metres in length and the difference of level between the extreme points is 1,300 metres. By reason of the difficulty of access to the line in winter, it was absolutely necessary to give to the poles the greatest stability and therefore many of them have been erected in duplicate, the one leaning towards the other. Wherever the lines cross a pathway they are surrounded by a guard net to prevent the wire falling on the path in case of breakage. The telephone wires (the line has a complete metallic circuit) are fixed underneath the three-phase wires and are crossed at intervals of about 500 yards, to reduce induction noises.

Until the tunnel is reached all the cables are carried on poles, but in the tunnel the high-tension line is laid underground in the form of a triple concentric cable. The cable is imbedded in sand and enclosed in an earthenware trough. A many-stranded telephone cable connects the sub-stations to Lauterbrunnen; this latter is also laid in sand and enclosed in an earthenware trough.

Since lightning is the cause of much trouble in this district, arresters of the Siemens and Halske horned type are placed at all points where injury could be sustained. It is interesting to note that statistics of accidents which have happened on telegraph lines show that such lines are more exposed to attack in the plains and valleys surrounded by high mountains than on the summits of the mountains themselves. Overhead wires in the neighbourhood of lakes are especially liable to be struck by lightning.



DIAGRAMMATIC SECTION THROUGH TUNNEL.

The trolley wires are calculated for a drop of 12 per cent. and consist of two copper wires, each 9 millimetres in diameter, supported by means of transverse wires from wooden poles placed on each side of the road. These poles also serve to support the telephone wires.

HIGH-TENSION TRANSMISSION LINE BETWEEN LAUTERBRUNNEN AND SCHEIDEGG.

The trolley wires are placed 4 metres above the rails and are suspended at 18 to 25-metre intervals by span wires. When exactly between the two stations, as in the cut opposite, which means 1,000 metres from the nearest transformer, there is a drop of 12 per cent. in the voltage. In this position the locomotive is obtaining half of the current from Scheidegg and half from Eigergletscher station, and the voltmeter registers the lowest voltage obtainable. As the locomotive leaves the central position, the volts rise gradually, in proportion to the distance of the locomotive from the transformers, and by this means the driver can tell almost exactly the distance his locomotive is from the nearest station, without reference to land marks or signals. Since the speed of every locomotive is almost constant, and signals are given at the station when they start, the drivers also know each other's position. The line is single in the tunnel and double in the stations, where the locomotives pass each other. If one locomotive arrives at the station before the other, it must wait for its arrival. If, on passing the centre point between two sub-stations, the loss increases above 12½ per cent., the driver at once knows that something is wrong, or that the other locomotive is on the same section. It will thus be seen that the system tends to great safety in working. Of course, the usual precautions of block signals, etc., are taken to avoid any possibility of an accident.

At one of its extremities the body of the coach is supported on the locomotive, whilst at the opposite end it is supported by a bogie. In this way the toothed wheel on the locomotive is kept in gear and the coach has no need of special brakes. The coach is pushed up the hill, and the coupling is sufficiently elastic to permit of easily passing the curves. The total weight to be moved is about 50 tons, with, say, 40 passengers. The coach is lighted with 15 lamps—5 between each pair of wires.

The frame of the locomotive rests on two axles by means of spiral springs, the play of which is limited to 10 millimetres in each direction. The first two locomotives put into use were built at the famous Winterthur works and equipped electrically by Messrs. Brown, Boveri & Co. Each of the two motors is capable of developing 150 horse power at 760 revolutions per minute, and it actuates a rack wheel through double reduction gear, disposed symmetrically on each side. The long cylinder immediately over the motors encloses the rotor resistance coils, there being one resistance for the two motors.

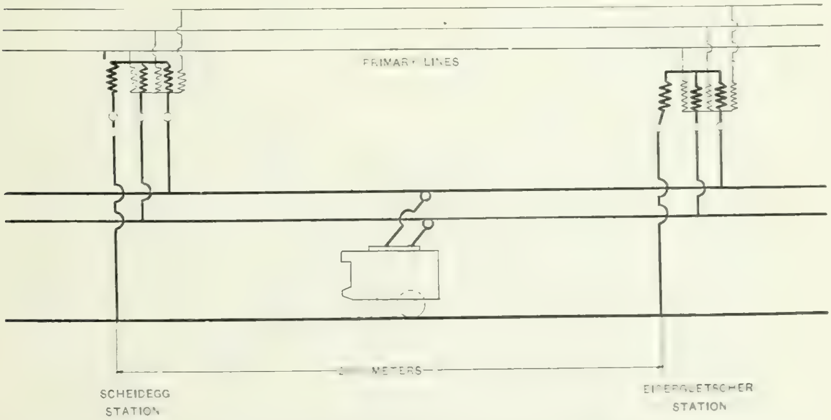
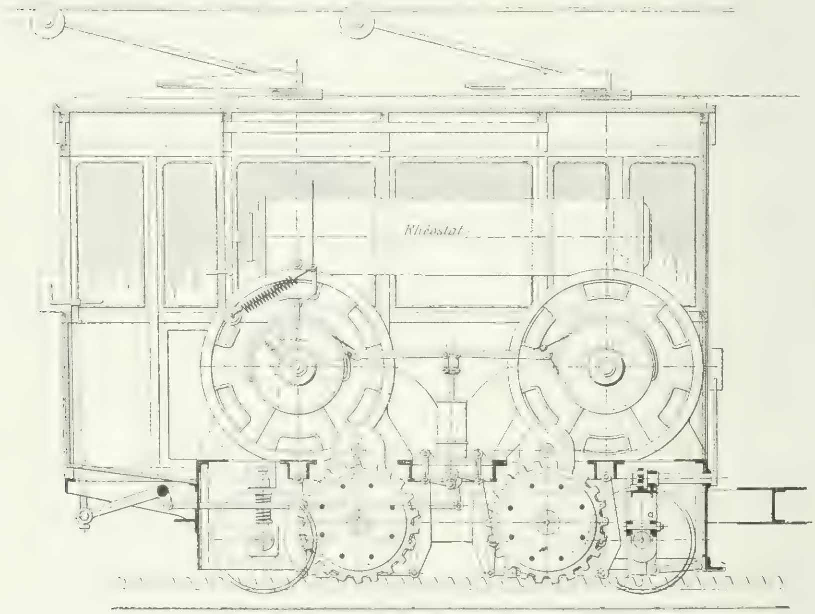


DIAGRAM OF PRIMARY LINES, TROLLEY WIRES, AND CONNECTIONS.

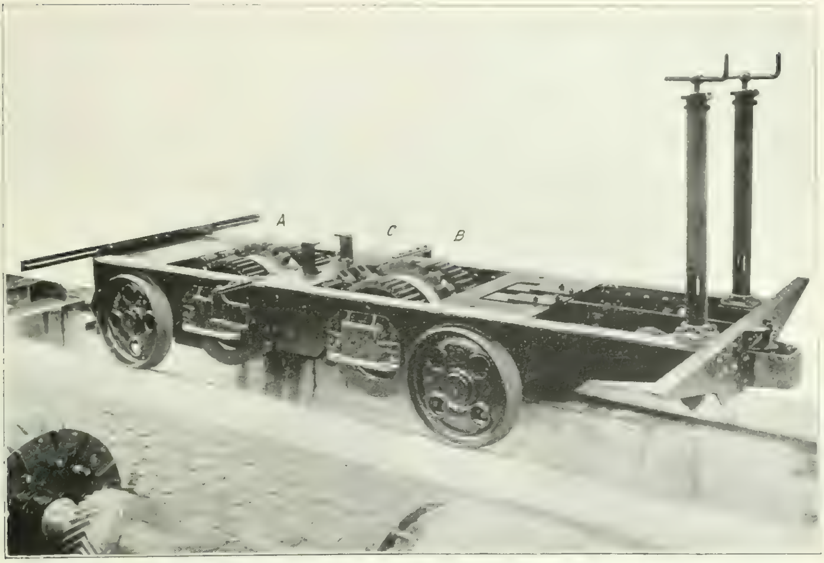
The superstructure of the locomotive is completely covered in by a wooden cabin, on account of the low temperatures which have to be encountered. Current is taken from the overhead wires by four trolley poles. The Oerlikon Company have recently supplied three more locomotives of greater power, representing the latest practice in three-phase locomotive design. Each of the motors gives 200 horse power when running at 550 revolutions per minute, the speed being reduced by two trains of gearing—1 to 4¼ and 1 to 2 respectively.

The truck (page 51) has four axles, the two inner ones being driving axles, carrying the rack pinions. These pinions (22 teeth) are of aluminum bronze, and forming an extension on either side are the grooved brake wheels, B. There are four of these brake wheels, each with four grooves, into which are set the brake blocks, C.



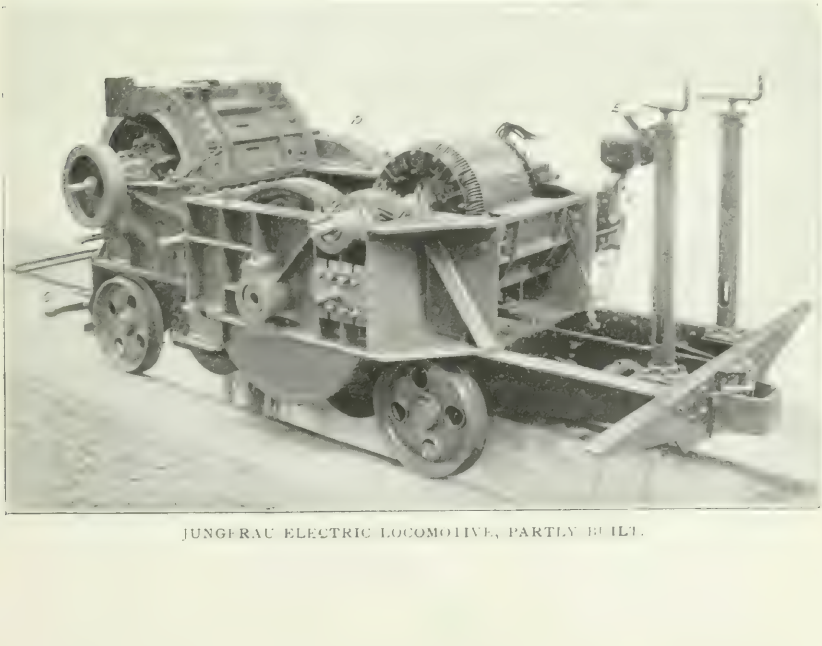
DIAGRAMMATIC SECTION OF LOCOMOTIVE, SHOWING AUTOMATIC BRAKE.

The double helical wheels, shown in the figure opposite, are the pinion and spur wheel, D, of the first reduction gear. The automatic brake gear, E, is worked by a chain from the motor shaft. Should the speed of the motor, by any chance, rise above a certain limit, a piece of metal on the rotating half of a friction coupling is moved out of position, causing the coupling to grip, and by this means rotating the screw, F, which is attached to the above-mentioned brake blocks. G is the projection for connecting to the passenger car, this latter resting on the locomotive at one end, so as to give greater adhesion and safety in working the trains.

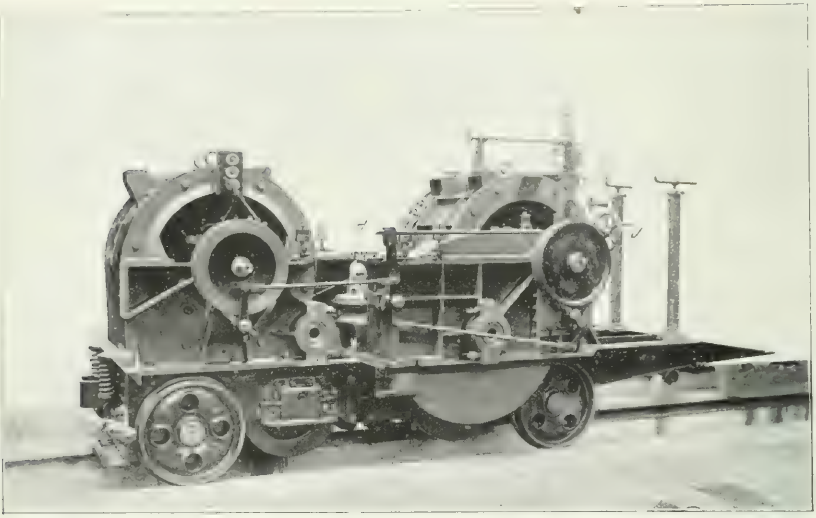


TRUCK OF ELECTRIC LOCOMOTIVE, JUNGFRAU RAILWAY.

There is a resistance for each motor, and H, (see next page), is a small three-quarter horse-power motor, which is coupled to a fan immediately below the coils. J is the wheel of the hand brake; the mechanism is plainly visible; the brake wheels are of cast iron, whilst the bands are lined internally with copper.



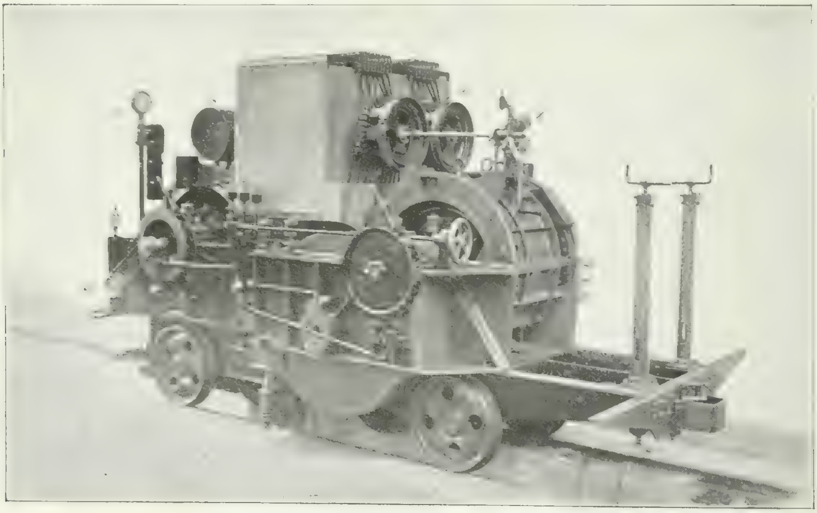
JUNGFRAU ELECTRIC LOCOMOTIVE, PARTLY BUILT.



A LATER STAGE IN THE ERECTION.

In the figure below, *d* indicates the rheostat switches, connected together by a steel band; 18 is a water reservoir, from which pipes are taken down to the grooved brakes, whilst 19 is a tachometer, on which the driver can read the speed of the motor shaft.

The completed locomotive is shown on page 54, and it will be noticed that two sliding contacts are used in place of trolley wheels.



READY FOR HOUSING IN.

The weight, complete, is 17 tons (or 5 tons heavier than the first locomotives); of this, each motor weighs 2 tons, and the cover 1½ tons.

Below is shown a diagram of connections of the Oerlikon locomotive, K being a three-pole switch, one pole of which is connected to earth. U is the reversing switch, and P is a switch for altering the resistance connections. On starting the locomotive up hill, K is open and the full resistance is in each rotor circuit to give the necessary torque. U and P are switched over to the up-hill position, and, as the locomotive speeds up, the resistance is gradually cut out. On the steep-

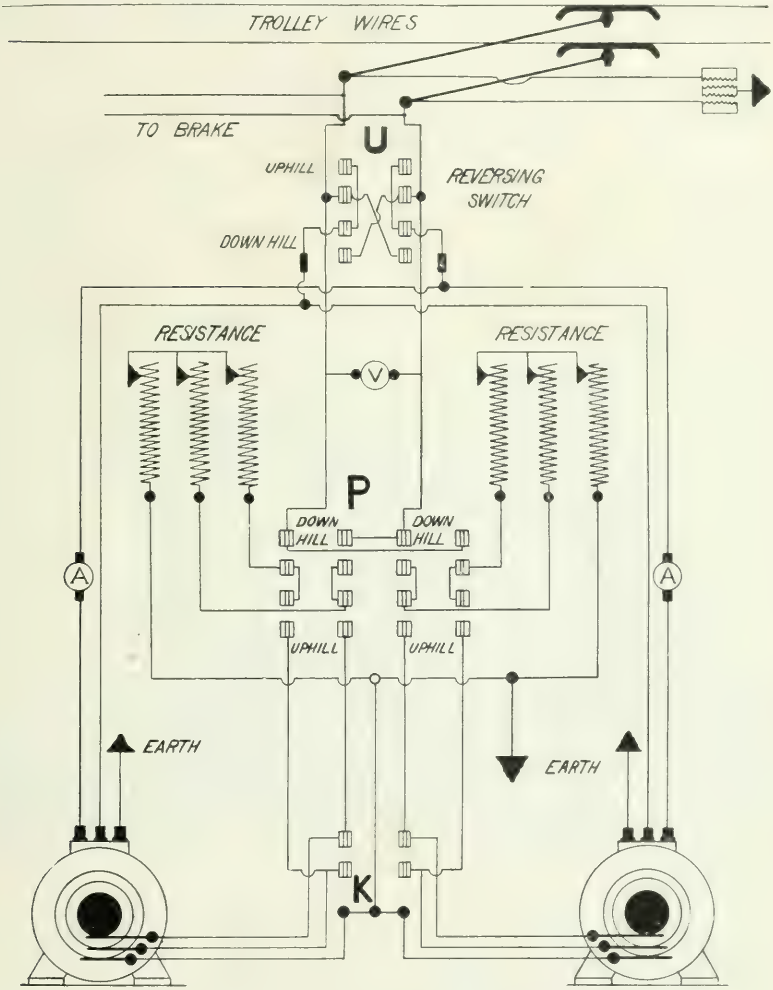
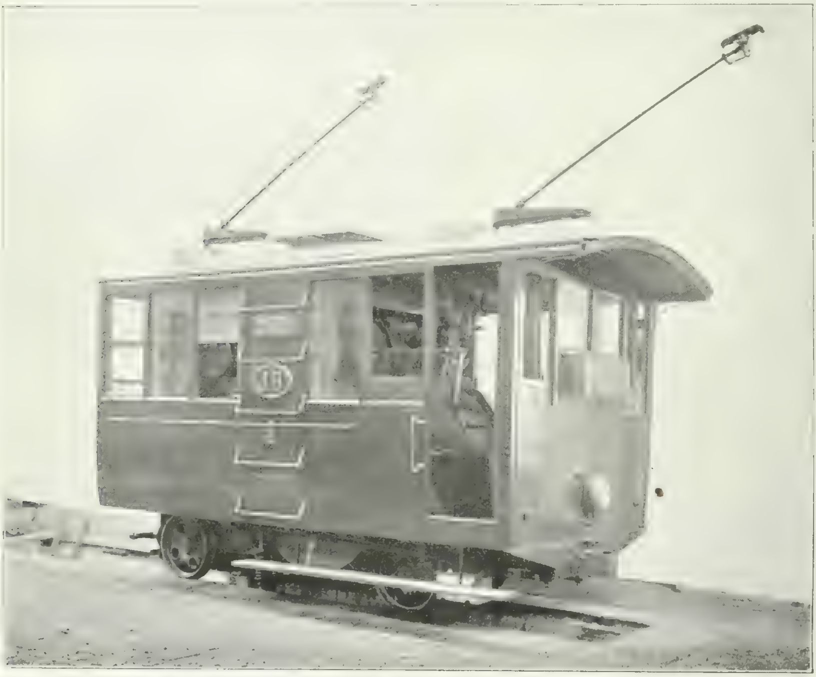


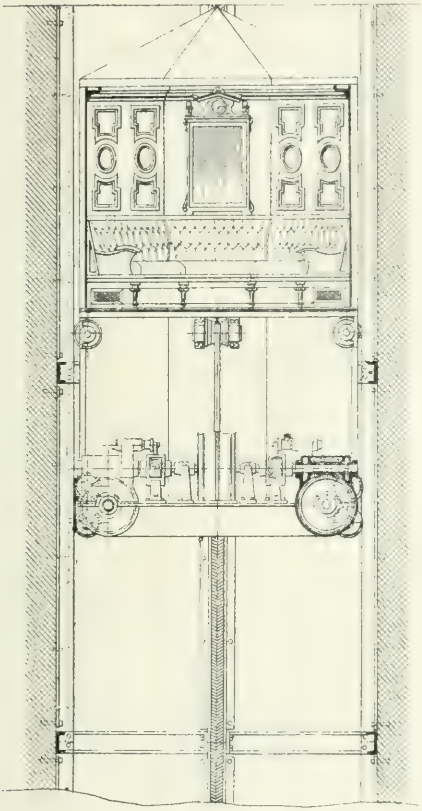
DIAGRAM OF CONNECTIONS OF THE OERLIKON LOCOMOTIVE.

est gradient the locomotive starts of itself directly the brake is taken off, but on low gradients current is necessary to start the locomotive, because of the rack friction. In this case, K is open and the full resistance is in each rotor circuit. U is reversed for running down hill, and P remains unchanged. When the locomotive has started, K is closed, the resistance is switched in and P connected for down-hill running. By following the connections it will be seen that the resistance is now in parallel with the stator circuit.

The reason for this arrangement is the small amount of traffic at present on the line. Suppose, for example, that only one locomotive is going up and another coming down, and that the latter has reached its highest permissible speed and is supplying current to the one going up. Now if the ascending locomotive stops at a station, or for any other reason, the load on the descending locomotive is suddenly removed and may cause a dangerous increase of speed—so much so that the generating plant at the central station may be motored round. In the first locomotives which were built, this contingency was guarded against by having a resistance in the main circuit at Lauterbrunnen, so that when a locomotive was about to start



JUNGFRAU RAILWAY ELECTRIC LOCOMOTIVE, COMPLETE.

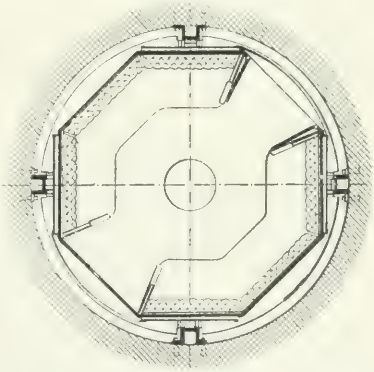

SECTION OF ELECTRIC LIFT.

it was necessary to signal to the central station to have the resistance temporarily switched in. When there is considerable traffic these inequalities of load on the generating plant will cancel out and the ideal method, in which those descending supply power to work those ascending, will be employed.

The last station of the railway will be about 66 metres below the summit, thus permitting the use of a rocky plateau about 30 metres wide and 4,100 metres high. From here travellers will be carried to the summit—4,166 metres—by means of a lift, which has been specially designed by the Oerlikon Company.

A three-phase motor is carried on the car itself and turns two toothed pinions working into two racks fixed along the walls of the pit. There are also two other racks, in which will be engaged toothed pinions working the automatic speed regulators. All the machinery is placed under the floor of the car, and great speed is obtained, together with absolute security.

The question of the utility of the railway has been frequently raised. At the present time the summit is reached several times a year, the time occupied being about 100 hours, and the expenses about 100 francs for each guide and 80 francs for each porter. When the railway is finished the traveller will be carried to the summit in


PLAN OF THE CAR.

about 2 hours, without any fatigue or mountain sickness, and at comparatively little expense. The view from the Jungfrau is probably unequalled in the world, commanding, as it does, a vast stretch of glaciers and the superb peaks—the Aletschhorn, Finsteraarhorn, Weisshorn, Dent Blanche, Monte Rosa, Mont Cervin, etc. Beyond the benefit that it will be to the tourist, however, there is the advantage of being able to establish a permanent meteorological observatory at so high an altitude* and the great impetus it gives to engineering development.

It would be premature to discuss in detail the financial results of the undertaking, but assuming that 17,000 persons are carried annually, the receipts would amount to £21,200, thus:

10,000 persons conveyed to Eiger and back at about 20s.	£10,000
7,000 persons conveved to Jungfrau and back at 32s.	11,200
	£21,200
The working expenses will probably be about	
10,000 car kilometres at 4 fr. 80 c.	1,920
Electrical service	480
Sinking fund, etc.	3,300
	£5,700

So that the excess of receipts over the expenses leaves £15,500, and on a capital expenditure of £300,000 this provides for a dividend of 5 per cent.

Aesthetic objections are met by the simple fact that the greater part of the line must of necessity be tunnelled through solid rock, and the openings or windows at the various stations, by which travellers view the surrounding scenery, cannot be considered a disfigurement.

One circumstance, particularly favourable to the working of the line by electricity derived from water power, is the fact that the variations in the output of the two Lutschines accord exactly with the movements of travellers—that is to say, during the summer months the output is at its maximum.†

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* The Railway Commission has to provide a sum of 100,000 francs towards the establishment of this observatory and contribute 6,000 francs annually towards its maintenance.

† In preparing the above article, I am indebted to various manufacturers of the plant, particularly the Oerlikon Company. I have also made use of such information as has already been published, including an important paper by M. H. Martin in Le Génie Civil.

THE WORLD'S SUPPLY OF COPPER.

By Frederick H. Hatch.

HAVING reviewed, in my preceding article, the general aspects of copper production and consumption—a subject of prime importance in view of the constantly expanding demands of the electrical and ship-building industries—and presented in detail the conditions in the United States, Spain and Portugal, and Japan, there remain for study the production of Chile, Germany, Australasia, and the thirteen minor contributing districts. For convenience of comparison, the table of production in 1898 is here repeated:

TABLE GIVING THE PRODUCTION OF FINE COPPER FOR 1898 IN VARIOUS COUNTRIES.*

Country.	Tons of 2,240 lbs.
United States	237,173
Spain and Portugal	53,225
Japan	25,175
Chile	24,850
Germany	20,085
Australasia	18,000
Mexico	10,435
Canada	8,040
South Africa	7,060
Russia	6,000
Norway and Sweden	4,095
Italy	3,435
Peru	3,040
Bolivia	2,050
Newfoundland	2,100
Austria-Hungary	1,540
United Kingdom	640
Argentina	125
Algeria	50
Total	427,118

Chile.—This country has been an important producer since the middle of the century, the total output of its mines from 1844 to 1898 being estimated at 1,771,000 tons of copper, chiefly exported to Great Britain in the form of "Chile bars." Its production now, although important, is about half what it was twenty years ago.†

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* Compiled from H. R. Merton's "Principal Copper Supplies" for 1899 and Rothwell's "Mineral Industry for 1898."

† About 1870, Chile furnished about half the world's supply of copper.

The figures of Chilian production for five years are:

Year.	Tons of 2,240 lbs. of Fine Copper.
1894	21,340
1895	22,075
1896	23,500
1897	21,900
1898	24,850

Two classes of veins are exploited, viz., veins of chalcopyrite associated with iron pyrites, with abundant copper carbonates and silicate near the surface, occurring in country rock of igneous origin, and more complex veins composed of sulphides of copper, lead, zinc, silver, and in some cases antimony. These ores are worked in innumerable mines, chiefly in the provinces of Atacama, Coquimbo, and Aconcagua. Among the more important mines may be mentioned: San Juan, Carrizal, Higuera, Tamaya, Panulcillo. The falling off in the output of recent years is attributable partly to the exhaustion of the oxidised surface ores, partly to internal political disturbances. The ores are mostly smelted locally; out of a total export in 1898 of 25,120 tons of metallic copper, 81 per cent. was in the form of bars, 7½ per cent. in mattes, and 11½ per cent. was ore.

Germany.—The bulk (90 per cent.) of the copper produced in Germany is furnished by the Mansfeld mines in the Southern Hartz. These mines exploit a thin bed of bituminous shale carrying copper (kupferschiefer) belonging to the Zechstein formation and extending over a superficial area of about 190 square miles. This seam is taken out to a width of about 15 ins., and for this width has an average copper content of 2 to 3 per cent. and a silver value of about 5 ozs. to the ton. It has been worked since the beginning of the thirteenth century, and by the fifteenth century the output had risen to about 1,000 tons of copper per annum. The metallic contents occur as a fine dust consisting of various copper sulphides (chalcopyrite, bornite, chalcocite), together with iron pyrites, galena, and small quantities of compounds of silver, cobalt, manganese, and other rarer metals. The mines are operated by the Mansfeldschen Kupferschieferbauenden Gesellschaft, of Eisleben. The ore is smelted in blast furnaces; the matte thus produced is roasted in kilns, and the gases are used for the manufacture of sulphuric acid. The roasted matte is smelted in reverberatory furnaces. The product consists of a second matte containing about 75 per cent. of copper and about 150 ozs. of silver to the ton, and copper bottoms containing 95 per cent. of copper and about 270 ozs. of silver to the ton. The second matte is roasted for treatment by the Ziervogel process, and the copper bottoms are refined by electrolysis.*

After Mansfeld, the most important copper mines in Germany are those of the Northern Hartz, of which Rammelsberg, etc., is the chief. The Rammelsberg deposit is a big lenticular mass (some 3,500 ft. long by 50 ft. wide), intercalated in slates of Devonian age. Both in mode of occurrence and in mineral character it resembles the Huelva deposits. The ore is cupriferous pyrites, consisting mainly of iron pyrites with chalcopyrite, galena, tetrahedrite, blende, and heavy spar. A small amount of copper is also produced from chalcopyrite deposits associated with the diabase and schalstein (diabase tuffs) of the Nassau district. The returns of copper produced in Germany during five years are, according to Merton:

Year.	Mansfeld.	Other Sources.	Total.
1894	14,990	2,210	17,200
1895	14,860	1,695	16,555
1896	18,265	1,800	20,065
1897	17,960	2,185	20,145
1898	18,045	2,040	20,085

Australasia.—The production of copper in Australia was already large twenty-five years ago, the principal source of supply being the rich oxide and carbonate ores of South Australia. The highest point was reached in 1884, in which year the total Australian output amounted to 14,100 tons. In subsequent years the output fell off, owing in a measure to the partial exhaustion of the rich surface ores, but also to the influence of the low prices which succeeded the undue inflation of 1888. Low-water mark was reached in the year 1892, with an output of only 6,500 tons. Since 1895 the production has made rapid progress, being helped by the opening up a new copper field in Tasmania. The production of copper in Australasia, according to H. Merton & Co.'s estimates, has reached the following totals:

Year.	Tons.
1894	9,000
1895	10,000
1896	11,000
1897	17,000
1898	18,000

It is not possible to estimate the production for each of the seven colonies separately, as the official returns give the value of the output only, and this includes the value of the gold and silver contained in the blister copper exported. The following table shows their value for 1898 and the value of the total production up to the end of the same year for each of the seven colonies.*

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* "Min. Industry," 1898, p. 245.

Colony.	Value of Copper Production 1898.	Value of Total Production, to the end of 1898.
Tasmania	£382,640	£874,516
New South Wales†	280,887	4,624,029
South Australia	248,857	21,529,746
Western Australia	4,266	172,115
Queensland	2,166	2,022,927
New Zealand	70	17,938
Victoria	Nil	206,395
	£918,886	£29,447,666

Calculating from these figures we find that the three first named colonies are at present furnishing 99 per cent. of the value of the whole output; Tasmania contributing 42 per cent., New South Wales 30 per cent., and South Australia 27 per cent., leaving 1 per cent. for the remaining four colonies.

Tasmania.—Although this colony has only recently entered the lists as a copper producer, it has already caught up the two other big copper-producing colonies, viz., New South Wales and South Australia, the output of each of which may be roughly stated at 5,000 tons of metallic copper. This rapid advance is to be attributed to the development of the Mount Lyell mine, which up to the present time has been the sole producer of the colony. Other properties are, however, being developed in the Mount Lyell district. According to official figures,‡ the copper raised and exported during 1898 was 4,956 tons of blister copper and 394 tons of ore.

Mount Lyell is situated in the western part of the island, 14 miles from Strahan, which is the base of supplies and port of shipment. Several new mines are in course of development, but the producing mine is the property of the Mount Lyell Mining and Railway Company. The ore-body lies between schist (hanging wall) and conglomerate (foot wall). It is a lenticular mass of pyrites, having a length of 950 ft., and a width, at the widest point, of 300 ft. Its depth is unknown. The ore consists of iron pyrites, carrying about 14 per cent. of chalcopyrite, and associated with heavy spar (about 2 per cent.) and silica (1 per cent.).§ The average metal contents of the ore are roughly; copper, 4 per cent.; silver, 4 ozs. to the ton, and gold 3 dwts. to the ton. The ore proper is overlaid by a gossan deposit consisting of hydrated oxide of iron and heavy spar, from which the copper has been leached out, but which carries good gold and silver values. The mine is worked on the "open-cast" system, and the ore is treated by pyritic smelting to matte, followed by Bessemerising of the matte and finally by electrolysis.

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* Statistics of the seven colonies of Australasia, by T. A. Coghlan, Sydney, 1899.

† The Copper Mining Industry, Vol. VI., Min. Resources of New South Wales, by T. E. Carne, Sydney, 1899.

‡ Progress of the Mineral Industry of Tasmania for the quarter ending Dec. 31, 1898.

§ Report by Dr. Peters.

The amount of ore treated during the half year ending March 31, 1899, was 102,978 tons (dry weight), having an average grade of 3.25 per cent. of copper, a silver value of 3.85 ozs., and a gold value of 2.28 dwts. Since the commencement of operations up to the same date the company has mined 322,510 tons (dry weight) of ore, having an average assay value of copper, 3.96 per cent.; silver, 4.17 ozs., and gold, 3.18 dwts. to the ton; it has produced 11,209 tons of blister copper, containing 98.8 per cent. of copper, 106.43 ozs. of silver, and 4.612 ozs. of gold to the ton; this corresponds to an average copper yield of 3.4 per cent., calculated on the ton of dry ore.

New South Wales.—Copper mining commenced in this colony in the year 1845, and from that date to the end of 1898 the value of the blister copper produced, including the contained gold and silver, is estimated to have been £4,624,029. The most flourishing period of the industry was in 1883, when the value of the production reached £472,982. The subsequent fall in prices and the exhaustion of the richer surface ores brought many of the mines to a close.

The value of the net export of blister copper, regulus, and ore from New South Wales, according to official statistics,[*] is as follows:

1894	£63,617
1895	136,969
1896	197,804
1897	283,174
1898	280,887

The principal copper mines at present producing are situated in the central part of the colony, between the Macquaire, Bogom, and Darling rivers. Chief among them is the Great Cobar mine, which was opened in 1876 and closed in 1889, having produced during that period 23,610 tons of copper. It was reopened in 1895 by the Great Cobar Mining Syndicate, which is now operating, besides this mine, the Nymagee and other large mines in the district. The production of the Great Cobar mine, from the reopening to the end of 1898, has been 10,414 tons of copper. The output for 1898 was 3,520 tons.

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[*] Carne, l. c., p. 180.

The ore-bodies consist of an admixture of chalcopyrite and pyrrhotite with iron ore and a small amount of quartz, occurring in lodes of varying width in ferruginous slates. Down to 300-400 ft. the ores consisted of carbonates and oxides of copper mixed with brown iron ore. In the local treatment the ores are first heap-roasted and then matte-smelted to 30-35 per cent. copper contents. The final yield is about 4 per cent. copper, ½ oz. of silver and 4 dwts. of gold to the ton. The gold yield, however, is enhanced by the use of gold quartz from neighbouring mines as a flux.

Other producers, but on a smaller scale, are the Burraga Copper Mining Co., the Girilambone Copper Mining Co., the Nymagee, the New Mount Hope, the Great Central, the Lake George United Mining Co., and the Broken Hill Proprietary Mines, the latter company producing copper in connection with its silver smelting operations. The production of these companies may be thus summarised.

Company	Nature of Ore	Copper Contents per cent.	First Opened in	Total Product, Tons	Output 1898, Tons
Great Cobar	Chalcopyrite and pyrrhotite	4	1876	34,024	3,520
Girilambone	Sulphides in quartz gangue	3.55	1880		421
Burraga	Chalcopyrite with quartz gangue	6.5	1880		570
Nymagee	Chalcopyrite and pyrrhotite	2	1880		728
New Mount Hope	Chalcopyrite below 160 ft.	4-5	1881	5,070	131
Great Central	Chalcopyrite below 200 ft.		1878	2,000	110
Lake George United	Chalcopyrite with pyrites, tetrahedrite, and zinc blende	1.45	1882		1,000

South Australia.*—The output for the entire colony of South Australia is a little less than 5,000 tons of copper, the bulk of which is derived from the amalgamated Wallaroo and Moonta mines. The Wallaroo mine is situated in Yorke Peninsula, Spencer Gulf. It was opened in 1860, and, prior to the amalgamation with the Moonta in

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* There is much valuable information given in the "Record of the Mines of South Australia. Copper." By H. V. L. Brown, Gov. Geologist, Adelaide, 1899.

1890, had yielded copper ore to the value of £2,229,096. The ore-bodies are large lenticular masses (sometimes 20 ft. in width), connected by thin strings, and occur in schistose rock. The secondary ores (atacamite, cuprite, melaconite, chalcocite, etc.) extend down to 150 to 200 ft., giving place at that depth to chalcopyrite. The ore, as raised from the mine, has a copper content of from 3 to 10 per cent.

The Moonta mine is ten miles from the Wallaroo, in Yorke Peninsula. It was opened in 1861 and amalgamated with the Wallaroo in 1890. The ore-body consists of a quartz vein (3 to 8 ft. in width) in porphyry country rock, the ore being chalcopyrite with some bornite. Down to 150 ft. secondary ores were mined—red and black oxides, black sulphides, and atacamite. The average yield of the ore mined is about 3 per cent.

The Burra-Burra mine, situated one hundred miles north of Adelaide, was famous in Australia for its rich carbonate and oxide ore, having yielded for many years an average return of 23 per cent. of copper. This mine was discovered in 1845 and opened two years later. By 1850 it had attained to a large yearly output. Blue and green carbonates and red oxide of copper were found down to a depth of 300 ft., after which black sulphide ores began to take their place; below 600 ft., the ore had changed to chalcopyrite. On the exhaustion of the rich oxidised ores, the mine closed down in 1877. During the 29½ years of its existence it had produced 51,622 tons of copper, and paid £800.000 in dividends. The Kapunda mine, fifty miles west of Adelaide, was discovered in 1842, and worked from 1844 to 1879, producing over 12,000 tons of copper. The ore consisted of carbonates, oxides, and native copper, giving place in depth to chalcopyrite.

Mexico.—Before the advent of the Boleo mine as a producer in 1887, the output of copper from Mexico was restricted to a few hundred tons per annum; and at the present time 90 per cent. of the production is derived from Boleo, as will be seen from the table:

PRODUCTION OF COPPER IN MEXICO DURING THE PAST FIVE YEARS.

	1894.	1895.	1896.	1897.	1898.
Boleo	10.374	10.450	9.940	10.170	9.435
Other Mexican mines..	1,400	1.170	1,210	1.200*	1,000*
Total............	11,774	11.620	11,150	11,370	10.435

The Boleo deposits are situated on the eastern coast of Lower California, the base of supplies being the port of Guaymas, on the opposite side of the gulf, whence the Sonora railway connects with the United States trunk lines. The deposits are stratified, the beds consisting of alternations of flows of trachytic and andesitic lavas with conglomerates derived from the volcanic rocks. The copper-bearing beds immediately overlie the conglomerates. There are three such beds, the lowest having a thickness of 2 to 10 ft., the middle of 2 to 3 ft., and the highest of about 3 ft. The copper occurs in various forms of the secondary ores, viz., oxides (cuprite and melaconite), carbonate (malachite and azurite), chloride (atacamite), silicate (chrysocolla). These minerals occur as spots, oolitic grains, and nodules (boleos) and small veins in a clayey deposit impregnated with carbonate and sulphate of lime and chloride of sodium. The ores have an average value of 5 to 11 per cent. They are worked by the Compania de Cobre del Boleo. The black copper resulting from smelting is shipped to the United States.

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* Estimated.

Canada.—Copper production in the Dominion of Canada is at present almost entirely confined to four districts, viz., Rossland (Trail Creek) and Nelson in British Columbia, Sudbury in Ontario, and Capeltown in Quebec. The following table summarises the output of copper (in tons of 2,240 lbs.) from these districts for five years:

	1894	1895	1896	1897	1898
Rossland	—	375	705	812	2,336
Nelson	—	50	1,000	1,542	1,873
Other districts in British Columbia	—	—	—	23	38
Total for British Columbia	145	425	1,705	2,377	4,247
Sudbury, Ontario	2,454	2,112	1,670	2,456	2,738
Other sources, chiefly Capeltown, Quebec*	856	1,386	815	1,081	1,029
Grand total for the Dominion of Canada	3,455	3,923	4,190	5,914	8,014

Rossland.—The gold copper mines of Rossland are situated in Trail Creek (a tributary of the Columbia River) in West Kootenay, a few miles north of the United States boundary line. The town of Rossland, which has sprung up within a few years to supply the wants of the mining camp, has railway connection both with the Northern Pacific and the Canadian Pacific Railways, but the ores are mainly shipped to American smelters in Washington. The ore-bodies are irregular masses occurring in basic eruptive rocks (gabbros and diabase), with which they are no doubt connected in origin.

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* By difference.

and consist of a massive aggregate of pyrrhotite and chalcopyrite. They are low grade as regards copper (average yield about 1.3 per cent.), but contain high gold and silver values. The chief producers are the Le Roi and the War Eagle. The main ore chute of the Le Roi is more than 400 ft. long and its width is from 6 to 30 ft. During 1898 this mine sent 42,779 tons to its smelter at Northport, Washington (sixteen miles from Rossland), and these shipments which yielded 825 tons of copper, 68,000 ozs. of silver and 52,850 ozs. of gold, corresponding to a yield of copper, 1.9 per cent., silver, 1.6 ozs., and gold, 1.2 ozs. to the ton.

Nelson is situated on the Kootenay Lake, in West Kootenay. The mines in this district exploit silver-copper ores, consisting of a mixture of chalcopyrite, bornite, and tetrahedrite in a varied gangue. The average copper contents is about 4 per cent., but the main value lies in the silver contents. The chief producers are the Hall mines.

The nickel-copper mines of the Sudbury district are situated in Ontario, the town of Sudbury, on the Canadian Pacific Railway, being the base of supplies. The chief mines of the district (Copper Cliff, Stobie, etc.) are operated by the Canadian Copper Company, who, after heap-roasting and matte-smelting, ship the copper-nickel matte to the Orford Copper Company at Constables Hook, New York, for refining. The ore-bodies are irregular masses occurring in basic igneous rocks, and consisting of an aggregate of pyrrhotite and chalcopyrite, with smaller quantities of various nickel minerals. The average percentage of copper in the ore smelted is 2.8, and of nickel 2.6.

Capeltown, Quebec.—The pyritic deposits at the Eastern Townships (Capeltown) consist of chalcopyrite and iron pyrites occurring in Pre-Cambrian rocks. They are worked chiefly for their sulphur contents, the bulk of the raw ores being shipped to the United States for the manufacture of sulphuric acid. A small amount is treated locally by the Nichols Chemical Co., the sulphuric acid produced being used in the preparation of superphosphate from Canadian apatite. The copper contents of the ores are from 3 to 4 per cent., sulphur averages 42 per cent., and there is a silver value of about 3 to 4 ozs. per ton. The two producers are the Albert mine and the Eustis mine, the former worked by the Nichols Chemical Company, and the latter by the Eustis Mining Company. The output for 1898 was 35,686 tons of ore, worth $143,884.

South Africa.—The copper production of South Africa is at present confined to the mines in Little Namaqualand, in the north part of the Cape Colony. The base of supplies is Port Nolloth, on the Atlantic coast, three hundred miles from Cape Town, which is connected with the workings by a light railroad (2 ft. 6 in. gauge) ninety-one miles in length. The mines are operated by two English companies—the Cape Copper Company and the Namaqua Copper Company. The principal mines belonging to the former company are Ookiep, Spectakel, Nababeep, and Koperberg; the work of the latter company is now chiefly confined to Tweefontein, the Concordia mine having been exhausted.

The ore bodies are irregular, massive deposits of copper and iron sulphides associated with basic igneous intrusions in the fundamental granite and gneiss of the country. At Nababeep the sulphides are intimately mixed with the component mineral of the greenstone, only in the richer places appearing in streaks, runs, and bunches in the body of the rock. At Ookiep the matrix of the ore is for the most part granite and gneiss, while at Spectakel the ores occur both in the granitic and in the basic intrusive rock. The bulk of the ore is chalcopyrite, but this mineral is associated with chalcocite, bornite, and iron-pyrites (marcasite). Cuprite and melaconite also occur, but in small quantities, while near the surface the carbonates (malachite and azurite) and silicate (crysocolla) are found. Some quartz and calcite occur in the gangue. Hitherto the Ookiep mine has been the principal producer. During the year ending April 30, 1898, 49,858 tons were raised from this mine, averaging about 10½ per cent. of copper. The sorted ore sent to the smelter averages about 17 per cent., and the resulting matte contained 51.8 per cent., of which 7,084 tons were shipped to Swansea.*

The Namaqualand Copper Company do not matte-smelt, but confine their surface operations to producing a high-grade concentrate (27 to 30 per cent. copper) by wet dressing.

The production of fine copper by the two companies for five years has been as follows (in tons of 2,240 lbs.):

	1894.	1895.	1896.	1897.	1898.
	1894.	1895.	1896.	1897.	1898.
Cape copper	5,000	5,350	5,470	5,290	4,660
Namaqualand copper	1,500	1,730	1,980	2,150	2,400
Total	6,500	7,080	7,450	7,440	7,060

Russia.—The principal supplies are derived from the Ural and the Caucasus, but other sources are the Altai and Finland.

	1894.	1895.	1896.	1897.	1898.
Output of Fine Copper in Tons of 2,240 lbs.	5,000	5,280	5,100	6,025	6,000

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* Communicated by Mr. J. A. Chalmers.

The copper deposits of the Ural occur mainly on the eastern flank of the Ural mountains, in the districts of Bogoslowsk and Nijni-Taguil. In the Bogoslowsk district they occur chiefly as contact veins between intrusive igneous rocks and limestones. The ores consist, in depth, of chalcopyrite in association with iron pyrites or magnetite and a quartzose or calcareous gangue. Near the surface the ores are decomposed to the usual secondary production—oxides, carbonates, chalcocite, bornite, crysocolla, etc. The ores from the various mines are treated at Bogoslowsk by the Manhès process.

In the district of Nijni-Taguil, a rich mass or pocket of secondary ores is worked at Mednoroudiansk. The large blocks of malachite extracted from this mine have made it famous. The ores consist of the carbonates, oxides, phosphate, and silicate of copper, with an occasional association of native copper.

In the Caucasus the principal producer is the Kiadebek mine, which has been worked by the Siemens Company since 1864. It is situated in the Government of Elizabethpol, thirty miles from Dalliar Station, on the Trans-Caucasian Railway. The ore-bodies consist of large, irregular masses and bunches in quartz trachyte, which has broken through the surrounding diorite.* The ore consists of chalcopyrite associated with iron-pyrites, blende, and pyrrhotite. Chalcocite and native copper are rare. In the gangue, heavy spar and quartz are found. The copper in the ore varies from 3 to 5 per cent. At the surface it is separated into furnace ores, averaging 7 per cent., and poor material for the lixiviation plant, averaging 3 per cent. The smelting plant consists of reverberatory furnaces, using raw petroleum which is pumped up from Dalliar Station. The matte thus produced contains from 23 to 30 per cent. copper. After roasting, it is smelted to blister copper in blast furnaces. The blister copper contains 88 to 90 per cent. of copper, 2 ℔s. of silver, and 1.2 ozs. of gold to the ton of copper. It is refined by electrolysis at Kalakent. The production of fine copper is about 1,800 tons per annum.

In the Altai the copper mines best known are those of Tschoudak and Songatof. The Tschoudak lode is of considerable width (up to 24 feet). The gangue is quartz, and the ore, below the zone of oxidation, chalcopyrite. In Finland the copper deposits of Pitkäranta have been worked for many years. The ore consists of chalcopyrite in a vein of sahlite, traversing granite.

Norway and Sweden.—The output from these countries during the past five years has been as follows:

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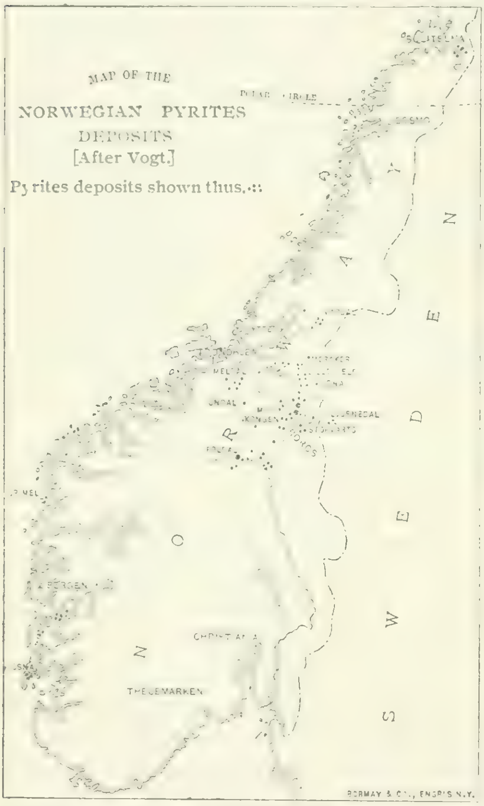
* G. Kolle, "Min. Industry," 1898, p. 246.

	1894.	1895.	1896.	1897.	1898
Norway	1,890	2,685	2,500	3,450	3,615
Sweden	350	515	500	545	480
Total	2,240	3,200	3,000	3,995	4,095

A large proportion of the production is due to the operation of the Röros and Sulitelma smelting works. The remainder is chiefly derived from foreign treatment of exported ores.


MAP OF THE NORWEGIAN PYRITES DEPOSITS [After Vogt.]

Pyrites deposits shown thus.∴

BORMAY & CO., ENGR'S N.Y.

The Sulitelma mines are situated in the province of Nordland in latitude 67° 15′. The port of shipment is Fineidet, twenty-four miles from the mines. The ore is chalcopyrite in association with iron-pyrites. After dressing, there are three products—smelting ore, having a grade of 7 to 8 per cent. of copper; lump pyrites, carrying on the average 5 per cent. copper and 45 to 46 per cent. of sulphur; and fines, carrying 3½ to 4 per cent. of copper and 45 per cent. sulphur.[*]

The Röros mines are situated south of Trondhjem on the railway from that place to Christiania. The ore-bodies are massive, often lenticular, deposits of pyrites occurring in metamorphic schists. In mode of occurrence and composition they bear a strong resemblance to the Huelva deposits. The ores consist of iron pyrites (greatly predominating), chalcopyrite, pyrrhotite, and blende, and are exploited for both their copper and their sulphur contents. Mining has been carried on in these deposits since 1646; the principal mines being the Storvarts, Ny Solskins, Mug, Christians, and Kongens. Similar deposits are worked at Vigsnäs, Foldal, Yttero, and other places in Norway.[*]

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[*] Longridge, London Mining Journal, Sept. 10, 1898.

[†] Vogt: l. c. p. 243, and Zeitsch. f. Prakt. Geol., 1894, p. 41.

The Swedish production is principally derived from the Falun deposits, which are worked in the neighbourhood of the village of Falun, northeast of Stockholm. The deposits are lenticular segregations of quartz in gneiss, carrying iron pyrites, pyrrhotite, and chalcopyrite. The bulk of the ore is of low grade, containing 1 to 2 per cent. of copper, and is used for the manufacture of sulphuric acid; the "hard ore," *i. e.*, quartzose rock containing chalcopyrite and carrying from 3 to 4 per cent. of copper, is smelted for copper after concentration. The principal mine of the district, the Storrgrufra, has been working for more than five centuries, and has produced more than a million tons of copper. The present rate of production is between 400 and 500 tons of copper per annum, besides which there is a small yield of gold and silver.

Italy produces nearly 3,500 tons of fine copper per annum, as shewn in the following table:

OUTPUT OF FINE COPPER IN TONS OF 2,240 lbs.

1894.	1895.	1896.	1897.	1898.
2,600	2,500*	3,400	3,480	3,435

Smelting is carried on at Leghorn, where the smelting works consist of four Manhès converters and four reverberatory furnaces for refining. They treat ores derived from three sources, viz.: Monte Catini in the province of Lucques, Mossetana, and Boccheggiano. The dressed ores delivered to the smelters have the following copper values: Monte Catini, 36.06 per cent.; Mossetana, 11.21 per cent.; and Boccheggiano, 11.61 per cent. Of these three sources Monte Catini furnishes the largest production. Its ore-body is a brecciated lode in red serpentised gabbro (porfido rosso) made up of fragments of basic igneous rocks and carrying chalcopyrite, often in considerable masses of unusual purity, chalcocine and, more rarely, native copper. The average value of the oresas mined is about 7 per cent. of copper.†

Peru, which before the war with Chile in 1879 furnished a considerable amount of copper, has since then until last year been a very small producer. The industry has, however, undergone a great revival, owing partly to the opening up of new deposits in the Cerro de Pasco district. The output for five years is as follows:

	1894.	1895.	1896.	1897.	1898.
Output of Fine Copper in Tons of 2,240 lbs.	440	450	740	1,000	3,040

Bolivia.—The only production of copper in this country is derived solely from the famous Corocoro deposit in the La Paz district south of the Lake of Titicaca. The deposit consists of a bed of clayey and gypseous sand, having a thickness of 2 to 30 ft. The copper occurs chiefly in the form of grains and nodules of native copper with which are associated oxides and sulphides of copper, *e. g.*, chalcocite and cuprite. The product shipped contains as much as 60 per cent. of metallic copper and is known as "*copper barilla*" (barilla de cobre). The output of copper from this source for the last five years has been as follows:

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* Estimated.

† "Mineral Industry," 1899, p. 215.

	1894.	1895.	1896.	1897.	1898.
Output of Bolivia in Tons of 2,240 lbs.	2,300	2,250	2,000	2,200	2,050

Newfoundland.—The bulk of the copper ores shipped from Newfoundland are mined by the Cape Copper Company, at Tilt Cove, and are sent for treatment to Swansea. The output from Tilt Cove for the last five years has remained constant at 1,800 tons of copper. In addition to this, in the year 1898, 300 tons of copper were produced from ores coming from Betts Cove.

The ore bodies worked are lenticular masses of cupreous iron-pyrites, occurring in archæan rocks. As in other deposits of this nature, the ore is a mixture of iron-pyrites and chalcopyrite. The ore shipped carries about 7 per cent. of copper.

Austria-Hungary.—The copper production of the Austrian Empire is derived chiefly from bye-products in the various smelting operations carried on in many parts of the country. The principal copper deposits, worked as such, are those of Kitzbühel in Tyrol, those of Schmöllnitz in Hungary, and those of Rézbánya and other districts in the Banat.

The Kitzbühel deposits consist of beds, or flat lodes, of chalcopyrite and iron pyrites in a gangue of siderite and quartz traversing Silurian slates. The principal mine is the Kupferplatte. At Schmöllnitz, the ore bodies are lenticular masses of cupriferous iron pyrites in slates resembling the Huelva deposits. The Banat deposits occur on the contact of diorites (banatites) with cretaceous limestone. Chalcopyrite occurs associated with iron pyrites, magnetite, and blende. A small amount of copper is also derived from Bosnia and Servia.

The output for five years is as follows:

	1894.	1895.	1896.	1897.	1898.
Austria	1.810	1.110	1,075	1,210	1,110
Hungary (including Bosnia and Servia)	310	200	210	445	430
Total	2.120	1.310	1.285	1,655	1,540

United Kingdom.—The copper production from ores mined in the United Kingdom, once so important, is now reduced to very small limits. At one time (1830) Great Britain furnished over one-half of the world's supply of the metal. In 1850 Messrs. Foster & Whitney put the output of Great Britain at 14,000 tons, the world's total being 46,000 tons,* while in 1863 the production of the metal from local sources was valued at over a million sterling.

The output is now chiefly confined to Cornwall, Devon and Wales. In Cornwall, copper and tin ores are mined in the districts of Camborne, Redruth, St. Austell and Carrodon. The ore bodies are veins traversing granite and slate (killas) and the vein-filling is chalcopyrite together with iron-pyrites, the tin stone, blende, galena, siderite, and quartz. The chief Cornish mines now producing copper are the Levant at St. Just, the Carn Brea and Tincroft at Carn Brea, and the Creegbrawse at Chacewater. The Welsh production is contributed by the Hurst's mines at Dolgelly in Merionethshire, and by old mines on Parys Mountain in Anglesea, where copper "precipitate" is obtained by the treatment of cupreous water pumped up from abandoned workings.

The output is as follows in tons of 2,240 lbs.:†

	1894.	1895.	1896.	1897.	1898.
Cornwall	242½	394	399	294	376
Devon	152	132	104	93	71
Other English sources	3	1¼	2½	—	—
Wales	3	1	9½	67	166¼
Ireland	—	—	—	18½	—
Angelsea "Precipitate"	46	51	41	45¾	27
	446½	579¼	556	518¼	640¼

It does not require a very prolonged study of the foregoing notes on the world's copper supplies to arrive at one rather striking conclusion, namely, that although there are a great number of copper mines scattered over the globe, a very large proportion of the whole production is derived from comparatively few mines. Thus we find that three mines alone produce 28 per cent. of the total output. They are the Anaconda, the Calumet and Hecla, and the Rio Tinto; and if we extend the list we find that half of the whole world's output is the production of eight mines. They are listed below in the order of the magnitude of their production for 1898:

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* U. S. Executive Document 69, p. 152.

† Blue Book: Mines and Quarries, 1899.

Name.	Tons of 2,240 lbs
Anaconda	47,830
Calumet and Hecla	41,101
Rio Tinto	33,705
Boston and Montana	27,700
United Verde	18,900
Mansfeld	18,045
Copper Queen	15,066
Tharsis	12,000
Total output of eight mines	214,347
World output	427,118

The dominating position taken by the United States among the contributors to the world's supply of copper has already been commented on. The immense activity of the Americans, added to their mechanical genius, has led to the initiation by them of a scale of operations hitherto unprecedented in the history of mining. But, if the increasing demand for copper continues, present sources of supply will soon be insufficient, unless production at the big mines can be still further stimulated. It is doubtful, however, whether the production of mines like the Anaconda and the Rio Tinto can be very largely increased. And there is another side to the question that must not be lost sight of—the more rapidly an ore-deposit is exploited, the sooner it will be exhausted. It is true that there are immense reserves of copper ore at Lake Superior, assuming that the beds can be profitably worked down to a vertical depth of 6,000 to 7,000 ft.; but it seems likely that even this source of supply will fail to cope with the inincreased demands of the early part of next century, and three or four decades will probably see it exhausted. We are bound to assume, therefore, that unless new and abundant sources for the metal are opened up in the early part of next century, or some substitute is found for it in the electrical industry, there is no prospect of copper being over-produced.

LIMITS TO THE USE OF FORCED DRAFT FOR MARINE BOILERS.

By Walter M. McFarland.

WE do not hear so much nowadays about boilers being damaged and trial trips lost on account of the use of forced draft, but about ten years ago this was a complaint not at all uncommon. A part of the reason for the change is, as will be seen later, the increased use of water-tube boilers; but, nevertheless, the known fact that forced draft can be used within limits on any boiler with decided advantage suggests an examination to determine, if possible, what those limits are.

In order to understand such a discussion, it is well to glance briefly at the history of forced draft, and the article of Mr. James Howden, read before the International Engineering Congress in Chicago, in 1893, from which the abstract in the next two paragraphs has been taken, gives this in excellent shape.

Like some of the other important matters in connection with marine engineering, the application of forced draft to marine boilers is due to an American—Mr. Edwin A. Stevens, of Bordentown, New Jersey. His earliest experiment was in 1827, when the boilers of the steamer "North America" were fitted with closed ash-pit draft. A little later Mr. Stevens also tried two other methods—that by closed fire room, and that which is now known as induced or suction draft. Still another form, which is still common where the vessels ply in fresh water, is that of a jet in the chimney. This, of course, is rarely used with boilers in connection with salt-water navigation. Forced draft has been used on American river steamboats in various places almost continuously since the earliest days; but, so far as naval vessels are concerned, there had been, until some twenty years ago, no attempt to secure the benefits of forced draft, except for its use on nineteen small gunboats during the American civil war by Engineer-in-Chief Isherwood, of the navy.

In 1875 Thornycroft & Company began the use of forced draft on the closed fire-room plan in their torpedo boats, and from this time on its benefits became so apparent that it was universally adopted where weight was an important item. In 1882 it was applied to larger vessels, for the first time since Isherwood's test, in the case of the Satellite and Conqueror, of the British navy. The results there were so satisfactory as to lead to the immediate adoption of forced draft for naval vessels of all sizes throughout the world.

In naval vessels there has always been a tremendous pressure upon the designer of the machinery to reduce his weights to a minimum, and the successful use of forced draft was hailed with delight, because it was at first assumed that by its use the capacity of the boilers could safely be increased about 50 per cent.—which, of course, meant a reduction of one-third in the number and weight of boilers, assuming that all other conditions remained the same. We shall see in a moment that the other conditions do not remain the same, so that, while the percentage increase may in some cases be considerably more than fifty above natural-draft power, this is accompanied by a diminution in the economy of steam production.

Before discussing the methods generally used for securing forced draft for sea-going vessels, it may be of interest to say a few words about the use of the steam jet for stimulating combustion. In the high-pressure steamers of western American rivers the whole of the steam generated in the boilers is available for blast purposes, just as it is in a locomotive, and under such circumstances it is obviously the simplest and most economical method of forcing the draft; but in sea-going steamers with surface condensers, where fresh water is very precious, it is also obvious that the possibility of using a steam jet for forcing the blast has decided limits.

In the United States navy the steam-launch machinery is of the compound or triple-expansion type, with surface condensation; but the draft is obtained with the assistance of a steam jet. This was brought about in the early days of Admiral Melville's incumbency as Engineer-in-Chief by the fact that his attempt to get very light machinery through the medium of forced draft with a blower was objected to on the score of noise—the little blowers, running at nearly four thousand revolutions per minute, making a decided hum. It became evident that a steam jet would have to be used, but there were no data in existence of the economy of different forms of jets; in other words, the jet had always been used where it made little difference whether it was wasteful or not, and no attempt had been made to measure the steam used to secure a given rate of combustion.

A very interesting series of experiments was conducted at the New York navy yard in 1890, where the evaporation and rate of combustion were measured in one boiler, while the amount of steam required to supply the jet for the first boiler was supplied and measured in a second one. Numerous forms of nozzle were tried, but it was finally found that a nozzle of the simplest possible form (consisting of two cones whose narrow bases were joined by a short cylindrical neck) was the best, and by making the little cylinder of the nozzle of various diameters it was finally found that a combustion of 26.9 pounds per square foot of grate per hour was obtained with an expenditure of only 12 per cent. of the steam evaporated. This result is worth knowing, because, except for its publication in the report of the Bureau of Steam Engineering, the results of these experiments have not appeared in print. A nozzle of the same general form, but with a still smaller cylindrical portion, used only 8.3 per cent. of the steam evaporated, but it gave a combustion of only 14.2 pounds per square foot. This lower percentage was due both to the fact that the draft was not forced so much, and to the greater economy of evaporation with the lower rate of combustion.

Of the various methods of forced draft already mentioned, two have had the greatest vogue; that where the fire room is closed and the air forced into it, and that where the fire room is open but the ash pit is closed, either in the simple form or as part of the casing over the boiler front, the air in either case being forced into the ash pit and into a casing around the furnace door and thence over the fire. A modification of this latter form, with considerable elaboration for the purpose of heating the air forced in, is the system of Mr. Howden, which has probably been used more extensively than any other in merchant vessels, and is used almost exclusively to-day in the express steamers of all the great mail lines.

The system in which the fire room is closed and the air forced in—then acting just as in the case of natural draft—is the one which has been used most in the naval service, for the reason that it requires the fewest fittings and, generally speaking, is the simplest. In all war vessels the boilers are below the protective deck in any event, so that it requires very little additional structural work in the way of bulkheads to provide for placing the fire room under pressure.

The system by induced draft or suction has been used to some extent, and quite successfully; but its use does not compare in extent with the other two already mentioned, and for the purpose of this article it need not be further considered.

As showing the tremendous increase in boiler power due to forced draft, we may mention that the boilers of the U. S. S. Trenton, built in 1876, gave 5 horse power per ton of boilers and water, while the Minneapolis and Oregon, built in 1891-2, as well as the Prince George, of the British navy, in 1896, gave more than 17 horse power per ton of boiler. The value of forced draft, combined with the express type of water-tube boilers, is shown by the data for the torpedo boats and destroyers, which, in some cases, have given results of more than 80 horse power per ton of boiler and water.

As already stated, it was in naval vessels that the great benefits to be derived from forced draft showed themselves in a most marked way, from the fact that in their case maximum power is wanted usually for a short time only, so that questions of the economical production of steam had very little weight. The only case in recent times in which forced draft was used under the conditions where it was expected to prove of most value, demonstrated this point of its short duration. The fight at Santiago lasted from the time forced draft was turned on until the Colon had surrendered—in all, four hours.

Inasmuch as the economy of steam production was of so little weight, the question of limitation in using forced draft has attracted attention from the injurious effects of high rates of combustion in boilers on trial trips, where every effort was made to get the highest power from the boiler. In the United States navy there was practically no trouble at all on this score, for the reason that Admiral Melville, who along with his intense spirit of progress has always exercised a wise conservatism, had insisted on providing an adequate amount of heating surface. The case where the greatest trouble was found was in certain English vessels, where the amount of heating surface per horse power had been greatly reduced, and in some cases was little more than one and one-half square feet per horse power. In the American navy the allowance was always at least two square feet. The trouble came in the form of leaky tubes in the combustion-chamber tube sheet, and in a great many cases it was found impossible to carry out the forced-draft trial to the full length of four hours. A partial remedy for this difficulty was found by the use of what is known as the "Admiralty ferrule," which had a curved flange protecting the end of the tube from the direct impact of the flame. It may be said, in passing, that these accidents happened always in the case of boilers with closed fire rooms, as none of the closed ash-pit type were used in the British navy. Of course, carelessness in firing might cause leaky tubes with any system of forced draft, as was found in the case of one American vessel where inexperienced firemen allowed the backs of the grate bars to become uncovered and the cold air from the ash pit had direct access to the tube sheets, causing a few leaky tubes by the end of the trial. Generally speaking, the closed ash-pit system has hardly any tendency to cause leaky tubes, for the reason that when the furnace door is opened to put in a fresh charge of coal a damper is shut in the duct leading to the ash pit, thus cutting off the forced draft and leaving the open furnace under exactly the same conditions that obtain with natural draft.

Some of the brightest minds in the engineering world were devoted to a solution of the problem of preventing leaky tubes, and experiments were made showing the direction in which immunity was likely to be secured—one of which was the importance of not making the tube sheets too thick; another, the absolutely vital importance of perfectly clean water, free from grease; and another, the necessity of having a thoroughly good fit of the tube in the tube sheet without excessive expanding.

It was also very evident that the question of damage to the boiler was much more dependent upon the proportion between the amount of coal burned and the heating surface than on the usual ratio of coal burned per square foot of grate. The modern furnaces are so well adapted to stand the stresses due to expansion that, so far as that part of the boiler is concerned, it makes very little difference what amount of coal is burned per square foot of grate; but experience seems to show that in cylindrical boilers, if the rate of combustion is such as to make the heating surface less than about two square feet per horse power, with good triple-expansion engines working with about 160 pounds' pressure, there is danger from leaky tubes. In this connection it is worth remarking that in boilers fitted with the Howden forced draft the rate of combustion per square foot of grate is high, so that the horse power per square foot of grate rises to as much as 22; but in all these cases the number of square feet of heating surface per horse power is close to two.

As was already remarked, the advent of water-tube boilers has removed this question of damage done to the tube ends by high rates of combustion from the region of practical consideration, owing to the fact that in well designed boilers of this type, where there is any adequate provision for expansion, there has been no case of damaged tubes, however rapid the combustion. At the engineering congress already referred to, Mr. C. D. Mosher gave a report of a test of one of his boilers, where the air pressure was 12 inches of water, giving an evaporation of 18.2 pounds of water per square foot of heating surface. In the trials of the Ward boiler prior to its adoption for the U. S. S. Monterey, the rate of combustion was 55 pounds per square foot of grate for a period of 24 hours without any damage whatever, and in a short test of the boiler of the U. S. S. Cushing, with an air pressure of 4 inches of water, the rate of combustion was higher than 60 pounds per square foot of grate without any damage. Indeed, this was one of the reasons which led to the readiness with which the water-tube boiler was accepted, although, of course, the prime reason was the reduction in weight.

Although in naval vessels the question of economy in evaporation was of secondary importance, it was nevertheless very interesting to have some actual data of the extra cost of forced draft, and Admiral Melville was the first one in authority to take any steps to procure this information. On the trials of the Newark, Concord, and some other ships, he had the coal used under forced draft accurately weighed, with the result of finding that the coal per horse-power was about 2.6 pounds, whereas before these actual trials many writers had estimated that the consumption would not be more than 1.8 or 1.9 pounds, and they had even figured on as low a rate as 1.3 pounds for natural draft. As a matter of fact, the most economical result which has ever been obtained with triple-expansion engines under conditions where the measurements could be absolutely relied upon was the case of the steamship Iona, where the trial was made under the direction of the research committee of the Institution of Mechanical Engineers, Prof. A. B. W. Kennedy and Mr. Bryan Donkin being in charge of the watches, with a thoroughly competent staff of observers. In this case, with every appliance for economy in the engine, and a remarkably economical boiler, the coal consumption was 1.5 pounds per indicated horse-power hour.

It may be said, in passing, that in the naval vessels tested under Admiral Melville's direction the ratio of heating to grate surface was about thirty to one, which would give good economy with a combustion of not more than 15 pounds of coal per square foot of grate; but obviously this ratio of heating to grate was too low for economy when as much as 40 pounds of coal were burned per square foot of grate, as was the case in the vessels tested. In the Iona, the ratio of heating to grate surface was seventy-five to one. It is unfortunate that no extended series of experiments on the economy of evaporation at different rates of combustion has ever been made on numerous boilers of different types. Almost the only one of which we have thoroughly reliable data is the case of the U. S. S. Cushing, where a very thorough series of experiments was made by a board of naval engineers under Commodore Charles H. Loring, U. S. N., and the fact of this being the only case has made it necessary to use this table in almost every article in which the question of economy at different rates of combustion was under discussion. This table, with certain derived figures for the purpose of this article, is given below:

FORCED DRAFT TRIALS OF BOILER OF U. S. S. CUSHING.

(Thornycroft boiler of Speedy type; weight with water, 11 tons; grate surface, 38 square feet; heating surface, 2,451 square feet.)

Coal per hour, per square foot of grate, lbs.	24.12	40.23	66.32
Evaporation f and a, 212° per lb. of coal, lbs.	9.72	8.84	6.51
Coal per hour per i. h. p., at 18 lbs water, lbs.	1.85	2.03	2.77
Coal per hour for 10,000 i. h. p., tons.	8.25	9.09	12.35
Coal per day for 10,000 i. h. p., tons	198	218	296
Extra coal per day over 24-lb. rate		20	98
Extra cost per day at $5 per ton		$100	$490
Number of boilers	20	13	11
Saving in weight of boilers and water, tons		77	99
Time for extra coal to equal saving in weight, days		4	1
Time for extra coal to equal saving in cost of boilers, days.		560	146
Same in months of regular service		36	9.6

It is evident, on an examination of the observed data of this trial, that the rate of evaporation falls off in a marked degree as the rate of combustion is increased, so that two subjects suggest themselves for investigation. One is: "How long a period would elapse before the saving in weight of boilers, due to the increased combustion, would be offset by the greater expenditure of coal?" and the other: "How long a period would elapse before the saving in the cost of additional boilers necessary to run at economical rates would be offset by the cost of the additional coal used, due to the reduced economy?"

As will be seen by the derived data, in the case of a ship of 10,000 horse power, fitted with boilers of the type used on the Cushing, the difference between working at a rate of 24 pounds per square foot and 40 pounds per square foot would make the extra coal used at the higher rate equal the saving in the weight of boilers in four days, while, at the much higher rate of 66 pounds per square foot of grate, the extra coal burned in a single day would equal the weight of the nine boilers and their contained water, which would be dispensed with when this higher rate of combustion is used. Assuming that coal is worth $5.00 per ton and that the cost of one of the boilers, with its fittings, is $8,000, it appears that it would require 560 days of operation to make the extra coal used at 40 pounds per square foot of grate equal the value saved in boilers, and 146 days in the case of working at 66 pounds per square foot of grate. If we assume that, as in mail steamers, the vessels are in port about half the time, this would mean that the periods in which the cost of the extra coal would equal the saving in price of boilers would be 36 months for the 40-pound rate and 9.6 months for the 66-pound rate.

In the foregoing I have simply compared the cost of the coal with the cost of the boilers, and have made no allowance for the earning power of the additional space, which would be saved in the case of long runs by using more boilers with a lower rate of combustion, nor have I made any attempt to allow for the fact that the deterioration of the boilers would undoubtedly be greater at the high rates of combustion than at the lower ones. To include all these factors would obviously complicate the problem seriously, but with a series of experiments at various rates of combustion, giving more points than in the case of the Cushing, so as to enable a fair curve to be made with accuracy, there is no doubt that it would be possible to lay out a series of curves for the different factors, from a study of which it would be possible to find exactly the rate of combustion with a given quality and price of coal that would prove most economical.

In the case of the Cushing we have already noted that, with the rates of combustion actually used, the additional amount of coal burned would be equal to the saving in weight of boilers in four days when the rate of combustion is 40 pounds, as compared with 24. It is quite evident that at some intermediate point, in the neighborhood of 30 pounds, the economy of evaporation would be increased enough beyond that at the 40-pound rate of combustion to make the balance between boiler weight saved and extra coal burned come at about six days, or the period of a Trans-Atlantic voyage. In such a case there would be no question of the possibility of carrying extra freight, and under these conditions this would be the most economical rate of combustion.

It becomes very evident from this discussion that the maximum rate of combustion to be used with advantage is not an absolutely fixed quantity, but that it depends upon the nature of the service to which the boilers are subjected and upon the possibility of damage to the boiler. In the case of water-tube boilers of proper design there is no danger of injury by any rate of combustion which would be thought of on other grounds, so that for this type of boiler the question is reduced to the nature of the service of the vessel on which the boilers are installed. In naval vessels, where maximum power is never wanted for more than a few hours at a time, it will probably be found that the number of boilers should be fixed by the consideration of the number which will enable long distances to be made with the greatest economy at the highest speed practicable for such conditions. In other words, in the case of a 23-knot vessel like the Minneapolis and Columbia, the highest economical cruising speed for long distances would probably be somewhere between 17 and 19 knots. If the number of boilers is chosen so as to give a high economy of evaporation under these conditions, there will be no difficulty in having ample power for the maximum speed.

In the case of merchant steamers, questions of economy such as we have just discussed at some length, based on the data from the Cushing, would be the guide in connection with the length of the voyage and the earning power of freight capacity. Each particular service would be a case by itself, which the competent designer could readily solve by taking some little trouble to secure reliable data.

In the discussion as to the use of forced draft, the necessity for it on more important grounds has led me to omit hitherto one of the real advantages which it possesses for service on war vessels, which have to take their coal wherever they can get it, and which frequently cruise under conditions where natural draft would involve the use of a large number of boilers under conditions that would be wasteful on the score of added radiation and similar losses. Where forced-draft appliances are fitted, the question of securing any desired speed becomes a very simple one. I have had personal experience with cases where the coal supplied was of poor quality, and where the best firing gave very unsatisfactory results so long as natural draft was depended upon. The boilers were fitted with closed ash-pit draft, and in a very little time after the blowers were started steam was raised to the desired point, and after that there was absolutely no trouble in maintaining it at an even pressure. In another instance, where a forced-draft trial at full power with all boilers was made, there was every evidence from the difficulty in maintaining steam pressure that the coal was of very inferior quality. After the trial was concluded the blowers were shut down with the intention of allowing the fires in two boilers to die out. Ordinarily this would have required more than an hour, and would have enabled the speed to be kept up much above the ordinary cruising rate while the fires in the boilers to be laid off were dying out. In this particular case, steam began to fall in less than ten minutes after the forced draft had been shut off, and it was found that the fires in the two laid-off boilers had gone completely out. With such coal, no pretense of maintaining designed power could have been made except for forced draft.

There are some drawbacks to the use of forced draft, of course, one being the additional machinery necessary to produce the blast and the attention it requires, and also the greater attention and skill which are required both in firing and in tending water. Where the men are trained, however, by frequent use of forced draft they become thoroughly familiar with it, and, in my experience, really prefer it in moderation to working with natural draft.

The best illustration of the benefit of forced draft, where the machinery has been under the charge of competent men, is the case of the Oregon at Santiago. Milligan's men had frequently been exercised in the use of forced-draft appliances, so that when the vital moment came for which they had been waiting since the journey from the Pacific began in March, they were ready; and in less than half an hour after the signal was given for full speed the great warship was driving ahead under the impulse of all the power in her great machinery, and carrying her guns forward to insure the destruction of Cervera's fleet. The "man behind the gun" did his part well, but if it had not been for Milligan and his "men behind the shovel" the Oregon would not have been the supreme factor in the fight at Santiago that she actually was. Here were all the conditions for success: an admirable design of machinery; the highest workmanship on the part of the builders; and unremitting care on the part of the chief engineer, his assistants and the men under them. Not a drop of salt water had ever gone into the boilers, nor any grease; every boiler had good clean fires in it; and the splendid Cardiff coal which Milligan had husbanded in the fighting bunkers for this very day was ready to do its work. Every one of these factors was necessary to success; none had been neglected; and therefore the success was complete.

THE GEOMETRICAL GENERATION OF IRREGULAR SURFACES IN MACHINE CONSTRUCTION.

By Henry Roland.

ONE highly important development of the tool-maker's art—that by which simple movements are compounded so as to generate geometrically those regularly-irregular surfaces which form the working faces of correctly shaped gear teeth—should be considered before the rapid review of tool-making advance can be considered at all complete.

This paper, dealing with the latest forms of gear-cutting machines, is therefore a supplement to the preceding series on "The Revolution in Machine Shop Practice."

The terms "geometric production" and "geometrically produced" are here used in a special sense, for want of an authorized term opposed to "mechanical production" and "mechanically produced," where such mechanical operations involve hand-made transfers of scribed lines to template surfaces.

Almost the entire round of machine forms are composed of spheres, cylinders, cones (which are cylinders of constantly varying diameter), and plane surfaces. These are simple geometric forms, readily produced by the use of the lathe and planing machine, although there is no machine tool in common use which will produce a really accurate plane surface, and the best flat work now known is merely an approximation, more or less close, to a true plane, and is produced by hand scraping and tested by being rubbed with "surface plates," which are themselves approximate planes dependent for their goodness on the skill of the hand scraper who finishes them.

There is, however, one highly important class of irregularly curved surfaces to be found in those coacting cam-faces which form the actuating parts or driving members of the toothed gear wheels which make an indispensable integral part of almost every machine constructed. It is not possible here to give even the briefest mention

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The series on The Revolution in Machine-Shop Practice began in the issue of this Magazine for October, 1899. The preceding topics have been:

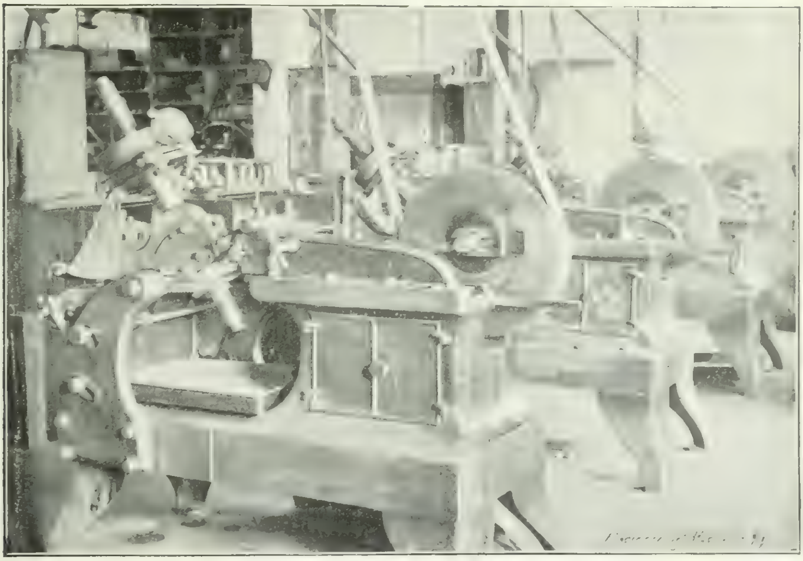
The Evolution of the Tool Maker.
Development of the Automatic Screw Machine.
Application of the Turret to General Machine-Shop Work.
The Practical Limitations of Tool-Making.
Application of Automatic Mechanical Production to Heavy Work.
The Machine Works of the Immediate Future.

of all the make-shifts by which passable approximations to the correct forms of gear teeth have been produced. The practice of the world up to about 1865 may be said to have consisted wholly of hand work in the production of machine gears, which were up to that time either formed by casting from wooden patterns having hand-shaped teeth, or, in case of large "mortise" wheels, by hand-shaping wooden teeth keyed into mortises in a cast-metal wheel. About thirty-five years ago the superiority of machine-cut gear teeth became so well understood that there is now a disposition to machine the teeth of all gears, of even the very heaviest class, with revolving cutters formed as accurately as may be to thin metal templets, which templets are themselves hand-shaped in accordance with approximately correct lines hand-traced on the templet blanks. Hence it may be said that no gear teeth very closely approximating to their really best forms were ever produced before the discovery that combinations of movements about centers could be made which would enable a cutting tool, having one of the simple geometric forms, to cut the infinite variety of shapes of wheel teeth which real accuracy demands.

In all forms of gearing the true shape of the working face of the gear varies with the number of teeth in each individual wheel, and hence, to approach the correct form with a hand-shaped cutter, there should be a different cutter for every difference in tooth-number of each pitch used, which is not commercially practicable. Hence all gear-cutting mills, commonly called "cutters," are approximations, each one made to cover as large a tooth-number variation as may be, and giving the truly correct form to none.

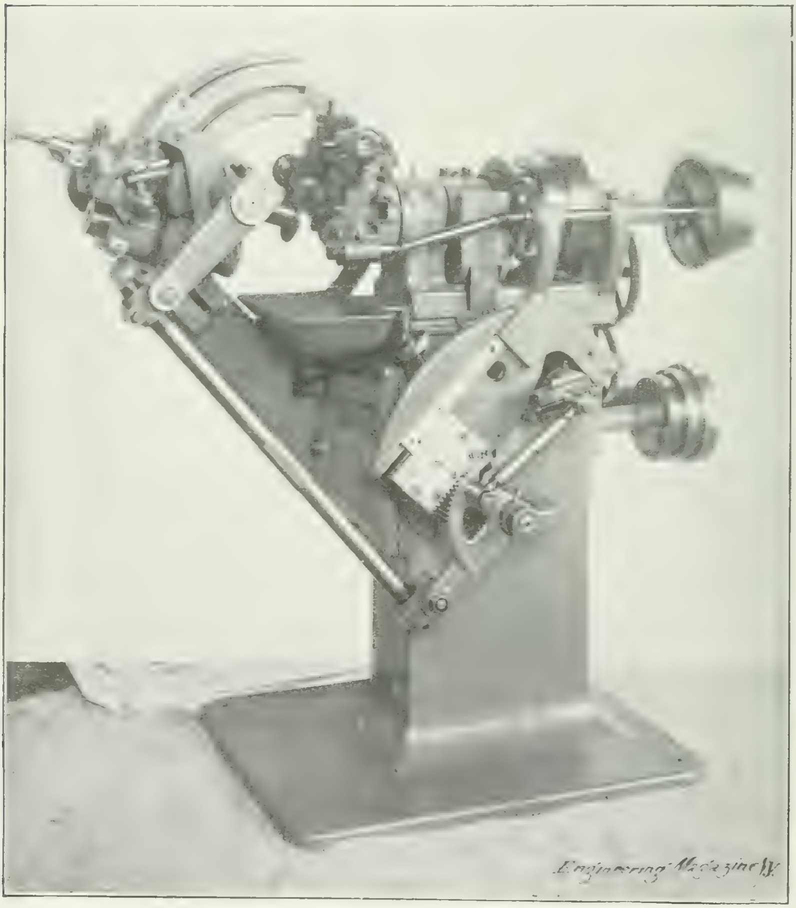
As previously mentioned, the only metal forms which can be geometrically produced involve the circle, and the only non-circular metal surface which can be tested for accuracy is the plane. It is obvious, therefore, that any machine which is to generate geometrically varying irregular forms bearing definite relations to each other, must derive its movements from circular and plane surfaces, since the correctness of no other surfaces can be accurately tested by methods practicable in the machine shop.

Almost any conceivable form of projection from the surface of a disk can be made to serve all the working purposes of an individual gear tooth, since some form of projection may be made on another disk which will take an impulse at uniform velocity therefrom, and the early millwrights and the makers of gear-driven bicycles of to-day meet on a common plane as producers of strange forms of gear teeth. But the wide demand is not for any form of gear tooth capable of special application only; what is wanted is a gear tooth of such shape that all diameters of driving-gear wheels shall impart a smooth motion at a continuous uniform speed to all diameters of driven-gear wheels having the same "pitch," or distance between the centres of adjacent teeth on the pitch circumference. This demand for interchangeability makes symmetry of tooth shape an indispensable requisite. Both sides of the tooth on any one wheel must be alike, and all teeth of any given pitch must be of the same total height, and have the same projection beyond the pitch circumference and the same descent below the pitch circumference into the body of the wheel; although, as before mentioned, correctly formed gear teeth can only have identical outlines in different wheels when both the number and pitch of the teeth are the same in each.



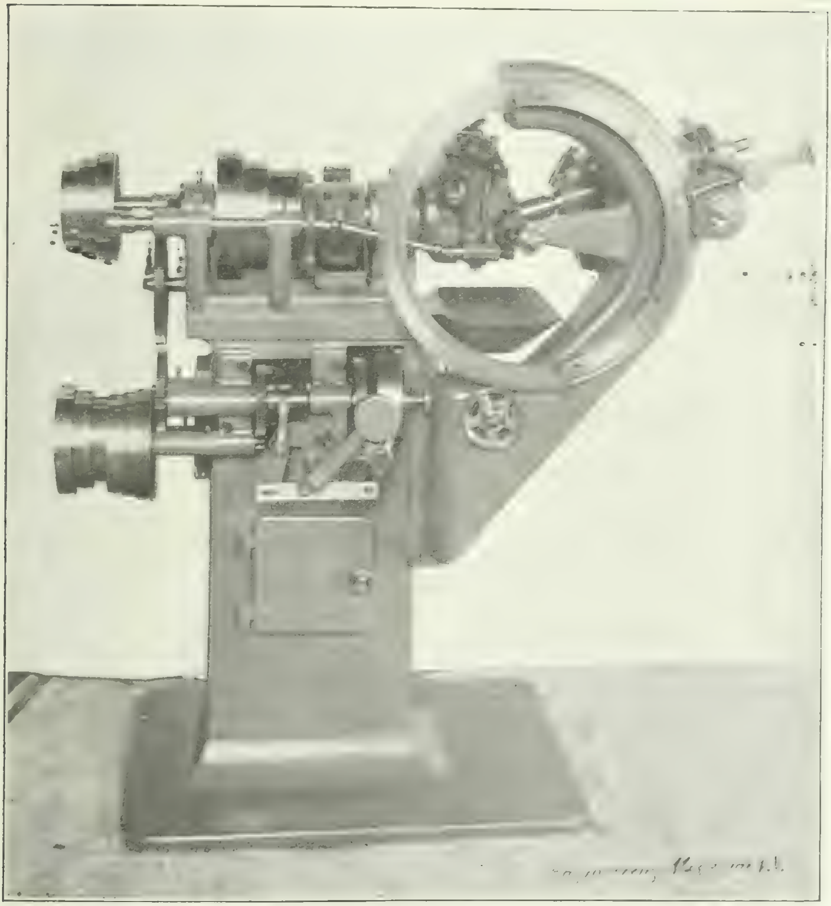
BILGRAM BEVEL-GEAR CUTTING MACHINES.

The common method of producing gear teeth to-day is to produce first a hand-shaped "templet," or reversed form in thin steel plate, of the space between two adjacent teeth of the desired form; next, to shape a cutter blank as nearly as possible to this templet; then to cut the teeth in the cutter and harden it; and finally, to cut a tooth space in the wheel blank with the cutter so formed, thus producing the opposed surfaces of two adjacent teeth. Then the wheel blank must be turned a certain distance exactly equal to the pitch of the teeth required, and held in this new position while a second tooth space is cut. This method of wheel-tooth cutting is rife with possibilities of error from beginning to end. First of all, the cutter must be of the correct form for the precise number of teeth to be cut in the wheel; next, this form must be set exactly perpendicular to the cutter axis of revolution, not leaning to either side in the slightest degree. Then the cutter must not change its form in hardening, or else must be ground to its correct form after hardening. When the cutter is placed in the gear-cutting machine it must be set so that the mid-line of the cutter points exactly toward the axis of revolution of the wheel blank, and also so as to enter the wheel blank to precisely



WARREN BEVEL-GEAR CUTTING MACHINE. PRATT & WHITNEY CO.

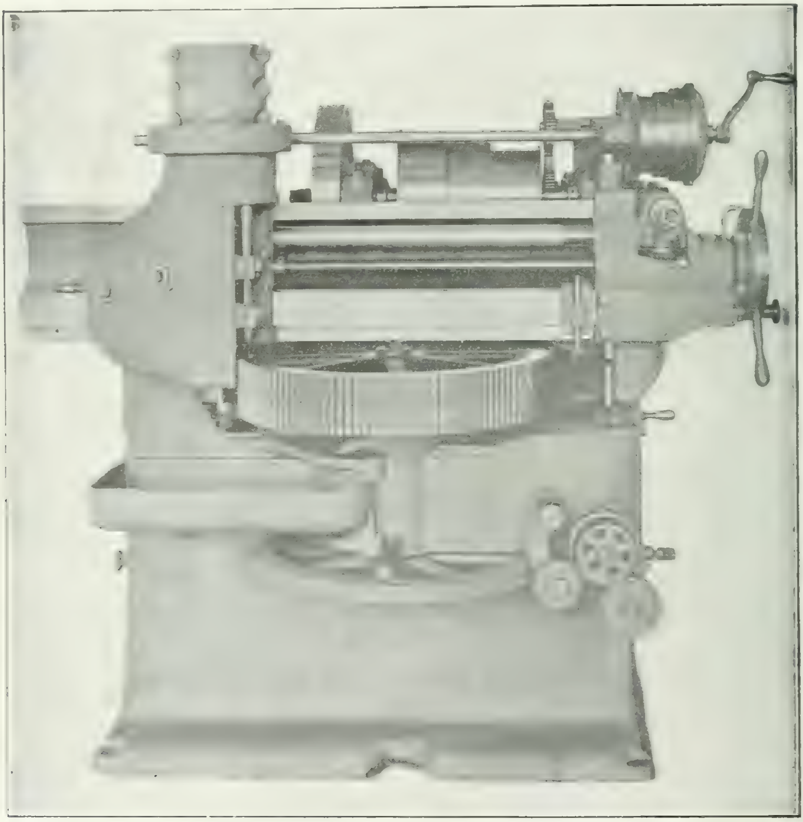
Largely used in cutting bevel gears for the chainless bicycle.



ANOTHER VIEW OF THE WARREN BEVEL-GEAR CUTTER.

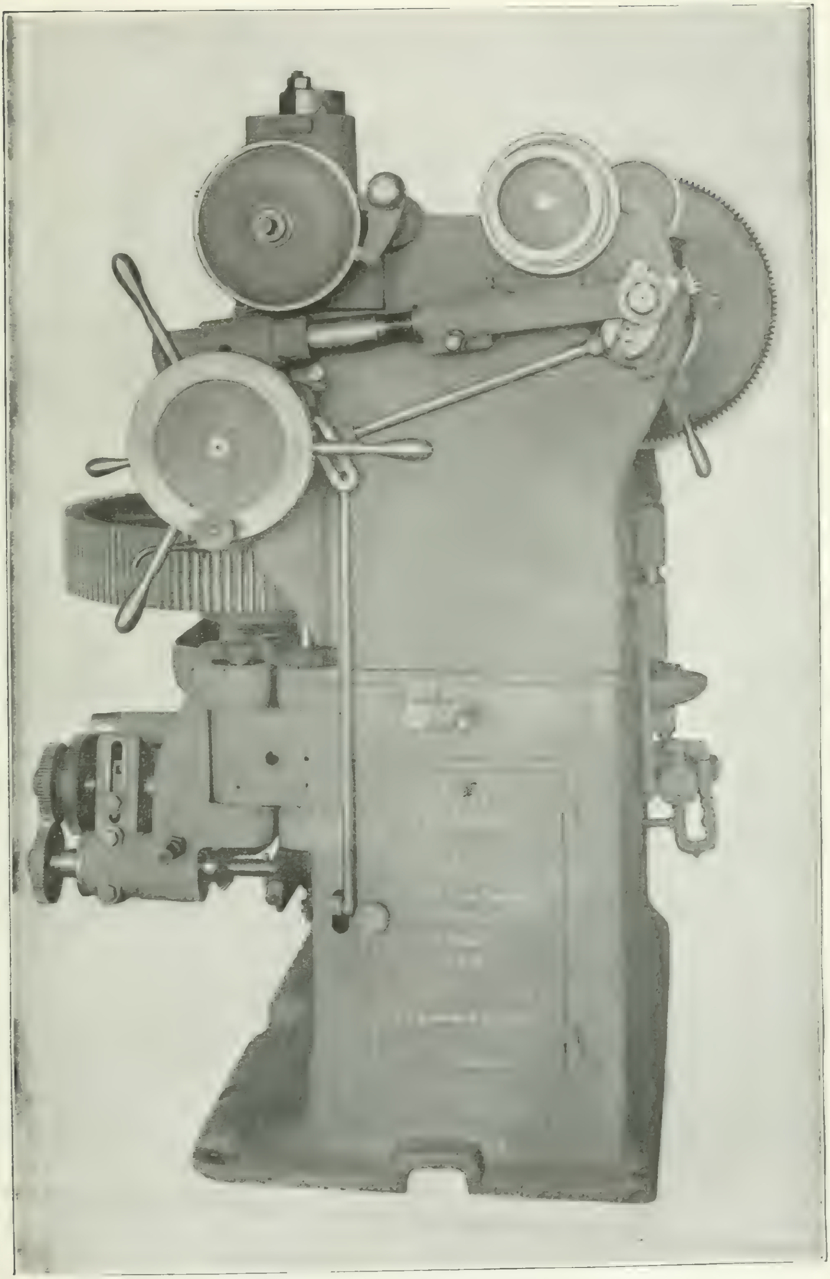
the correct depth. Finally, the index plate or wheel, by which the blank is turned the right distance from one space cut to the next, must be perfect in its own spacing, since if it is not perfectly uniform some teeth will be thicker and some thinner than others. Again, as mentioned, each different number of wheel teeth demands a different shape of cutter, which is a commercial impossibility, because it calls for an unendurable cost in the great number of cutters needed for each different pitch of toothed gear produced. Hence it is customary, even in the best practice, to make a comparatively small number of cutters serve for all numbers of wheel teeth, from say twelve for the smallest pinion, to a rack or wheel of infinite diameter, eight different cutters for each pitch being regarded as good practice, although it is quite impossible that any of the cutters except that for the rack should be of the really correct form, since all the others must be approximations to two or more different forms.

There are two distinct forms of gear tooth in approved general use, the epicycloidal and the involute; the epicycloidal gives the more nearly uniform driving impulse, provided that the two coacting gears are perfectly accurate in dimensions and form and are also set exactly the right distance apart. The involute gear is less affected by an incorrect spacing between the axes, and has the additional advantage of having straight lines for the sides of its rack teeth, and because of these two peculiarities the involute gear tooth is more easily produced than the epicycloidal, and is in very general use.



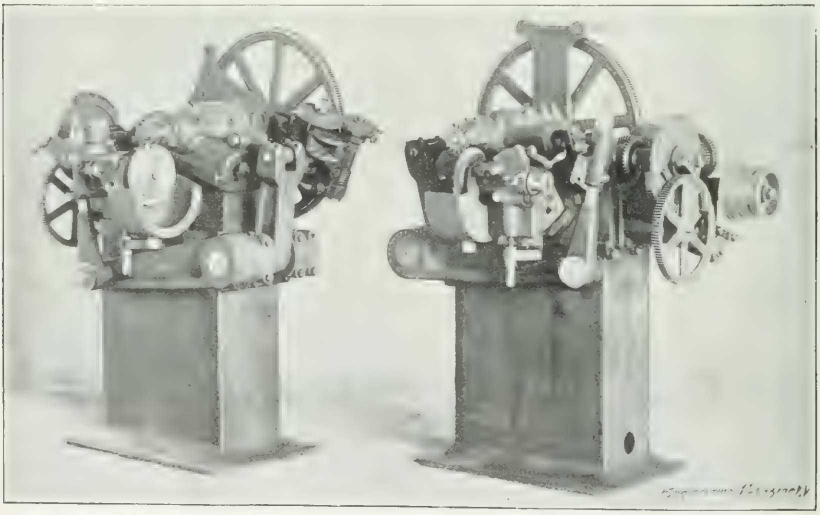
THE FELLOWS GEAR SHAPER CUTTING SPUR GEARS. FACE VIEW.

The rack, or straight line of teeth, may be regarded as the founda-



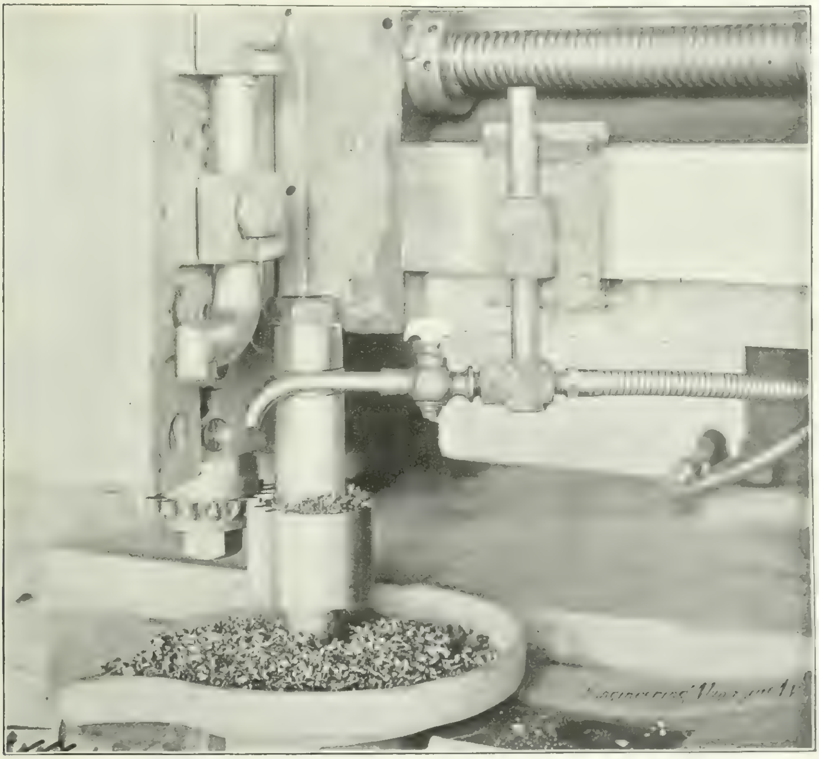
THE FELLOWS GEAR SHAPER CUTTING SPUR GEARS. SIDE VIEW.

tion of any system of gearing, because, supposing a plastic pinion blank to be rolled at a uniform velocity along the rack, it is imaginable that pinion teeth of correct form would be produced on the pinion blank. Again, elaborating this fanciful and wholly impossible conception of the rigid rack and plastic pinion blank, supposing that a pinion with correctly shaped tooth is thus geometrically produced, without hand intervention and error, and that this pinion is hardened into rigidity; then this now unyielding pinion, if rolled at correct speed against another plastic blank of different diameter, would also produce correctly shaped teeth on the second blank, or would correctly reproduce the teeth of the original rack, if constrained to roll a plastic surface at the proper rate, in a straight line. The first person, so far as known to me, to entertain this wholly impractical flight of fancy was Christian Schiele, Oldham, Lancaster, England, who filed a provisional specification in the English patent office, Dec. 26, 1856, for "certain improvements in machinery for cutting nuts, screws, or bolts, and toothed wheels." Space permits but a brief notice of Schiele's gear-cutting methods. They involved the use of a "worm-hob," which is simply a short screw, made of tool steel, having straight inclined sides to its threads, and having its threads cut across and "cleared" to form an endless series of cutting teeth—all in a manner perfectly well known before Schiele's day, but previously employed only as a suitable cutter for forming the teeth of "worm wheels,"



CUTTER-FORMING MACHINE FOR THE FELLOWS GEAR SHAPER.

adapted to be driven by a screw having its axis usually at right angles to that of the worm wheel. Schiele saw that by gearing a worm hob to the correct speed with a wheel blank, setting the hob at the correct angle, and then feeding the wheel blank slowly to the worm hob while both were revolving, the hob teeth would cut correctly formed teeth on the wheel, no matter what the wheel diameter might be, provided that the hob worm or screw was correctly shaped. Schiele's specification tells how to cut bevel gears with a succession of sinking cuts made worm-gear fashion with worm-hob cutters of different pitch, concluding by saying: "The joining of the different cuts will have to be made by filing to even surfaces." This is a very raw method of producing bevel gears, but Schiele's method of producing spur gears with a worm-hob cutter is perfectly correct and wholly practicable, although, so far as I am informed, two spur gears cut at the Pratt &



SHOWING CURLED CHIPS PRODUCED BY CORRECT CUTTER-FORM IN CUTTING STEEL GEARS.

Whitney shops at Hartford, under the direction of Francis H. Richards, constitute the entire product of the United States of spur gears cut by this method. An engraving of one of the worm-hob cut spur gears is given below, photographed from one of these Richards wheels, loaned for the illustration of this article.

It will be observed that Schiele's method wholly obviates the errors due to the use of the dividing plate, as the dividing plate is eliminated.

A SPUR GEAR CUT BY SCHIELE'S METHOD.

It is, however, needful that the gears used to give the worm hob and the gear blank their relative speeds should be correctly spaced.

Schiele's claim on gear-cutting mechanism is as follows:

"And lastly I wish it to be understood that I do not claim the cutting of worm wheels as hitherto practiced, but I claim the method of obtaining a more continuous and correct cutting of other wheels, by using a divisional or regulating wheel' [meaning the gearing which gives the relative continuous rotation to the hob and gear blank] "in connection with a worm cutter, so shaped and guided in its action as to produce the required forms of teeth independent of its tendency to act as a propelling screw or worm on the wheel; also the method of fixing and adjusting the larger kind of cutters" [inserted worm-hob teeth, keyed in] "and also the general arrangement and construction of such cutters, and the machinery or apparatus to be employed for cutting or trimming the teeth of spur, oblique, or other toothed wheels, as herein before described, fully set forth and exhibited by drawing attached." [Not reproduced here.]

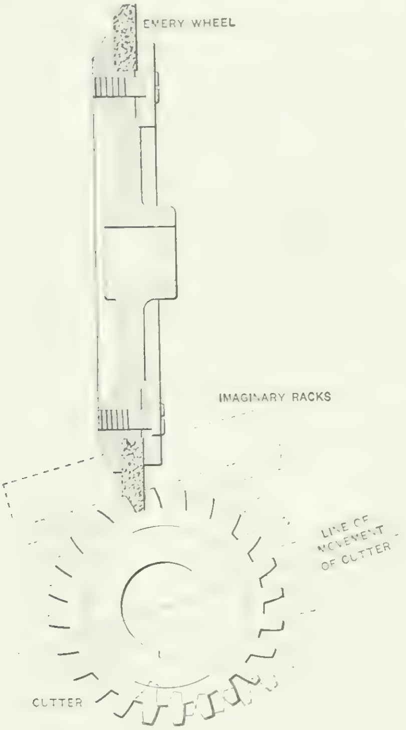
In 1877 there appeared in the *Verhandlungen des Vereines zur Beforderung des Gewerbfleisses* a long article by Professor Hermann, of Aachen, discussing very completely the whole subject of the origination of theoretically correct tooth outlines by the relative movements of the gear blank and tool, and among the numerous illustrations accompanying this paper were shown simple arrangements of gearing by which any ordinary slotter or shaping machine could be used to produce teeth of either involute or epicycloidal shape, without templates or formed cutters. The machines and methods discussed in this paper are practically identical in principle and operation with those now in actual use, but it does not appear from Professor Hermann's article that he actually constructed or operated any gear cutters upon the principles so fully expounded by him.

So far as I am informed, the first one in the United States to advance Scheile's general conception was Hugo Bilgram, of Philadelphia, who produced a highly ingenious and thoroughly practical machine of the shaper type, by means of which bevel gears are cut rapidly and with accurately formed teeth by the use of a rack-tooth shaped planing tool. Before this beautiful invention of Bilgram's there was no machine which could accurately generate bevel-gear teeth.

A very ingenious machine was designed by Mr. Ambrose Swasey, of the firm of Warner & Swasey, in which all the teeth of a set are generated at the time of cutting by the use of revolving cutters having the form of the rack tooth. The cutting tool in this machine is composed of a series of cutters rigidly connected; it revolves and at the same time moves longitudinally at right angles to the axis of the wheel to be cut, at the same speed that the latter is revolving at the pitch line, the motions being the same as in the case of a rack engaging with a revolving gear. This machine is fully illustrated and described in a paper by Mr. Swasey in the Transactions of the American Society of Mechanical Engineers, Vol. XII., 1890. It has been manufactured for their own use solely, and is not upon the market.

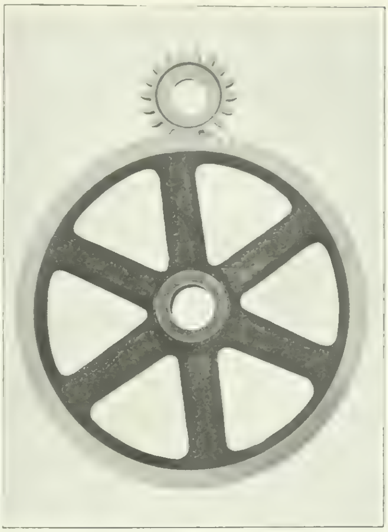
Barnes, of Rockford, Illinois, produced a machine in which bevel gears of approximate accuracy are cut with spur-gear cutters, the different widths of cut needful for the bevel-gear space being obtained by vibrating the cutter from side to side, the arc of vibration decreasing as the cutter goes towards the smaller diameter of the gear blank.

Warren, of Hartford, Conn., produced a very elaborate and thoroughly practical machine involving the vibratory method, which generates a correctly formed bevel-gear tooth by the use of a rectangular cutter.



The gear shaper built by the Fellows Company, Springfield, Vermont, generates correctly shaped spur-gear teeth by reciprocating an accurately formed cutter, finished to correct shape after hardening, across the face of the gear blank to be cut.

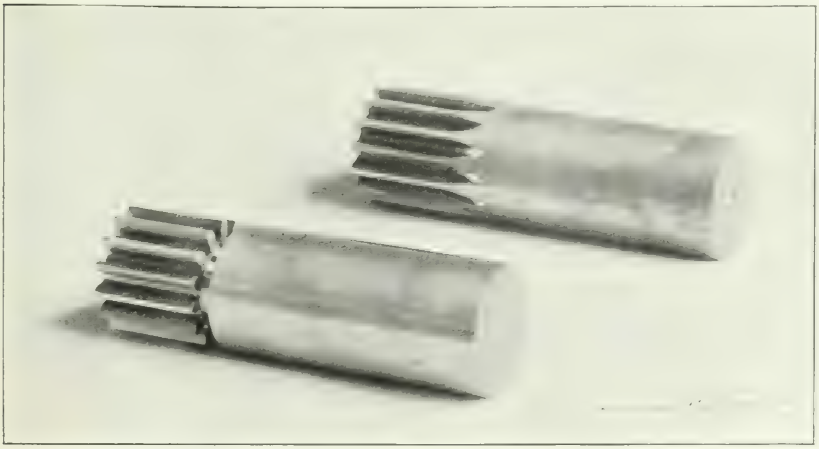
The "involute" rack, which may be regarded as a wheel of infinite diameter provided with involute teeth, has teeth with straight sides. The problem which Mr. Fellows set before himself was the geometric production of one single hardened tool-steel cutter, generated from an ideal and non-existent involute rack, which should accurately conform in its cutting contour to the lines of a pinion having the same number of teeth shaped to exactly coact with this suppositititious rack. Above is a diagram of the method adopted for this cutter generation. The emery-wheel flat face represents one side of a tooth of the imaginary rack, the complete imaginary rack being shown in dotted lines. The face of this wheel is cut to a perfectly flat disk by a mechanically guided diamond tool. The cutter blank, previously roughed out and hardened, is then rolled past the revolving emery wheel with a true rack-guided pinion movement, the cutter blank passing the emery wheel with its teeth in precisely the position they would occupy if the emery wheel were one face of a tooth of a rack with which the blank was in mesh. This motion of the blank is ob-



FELLOWS METHOD OF GEAR CUTTING.

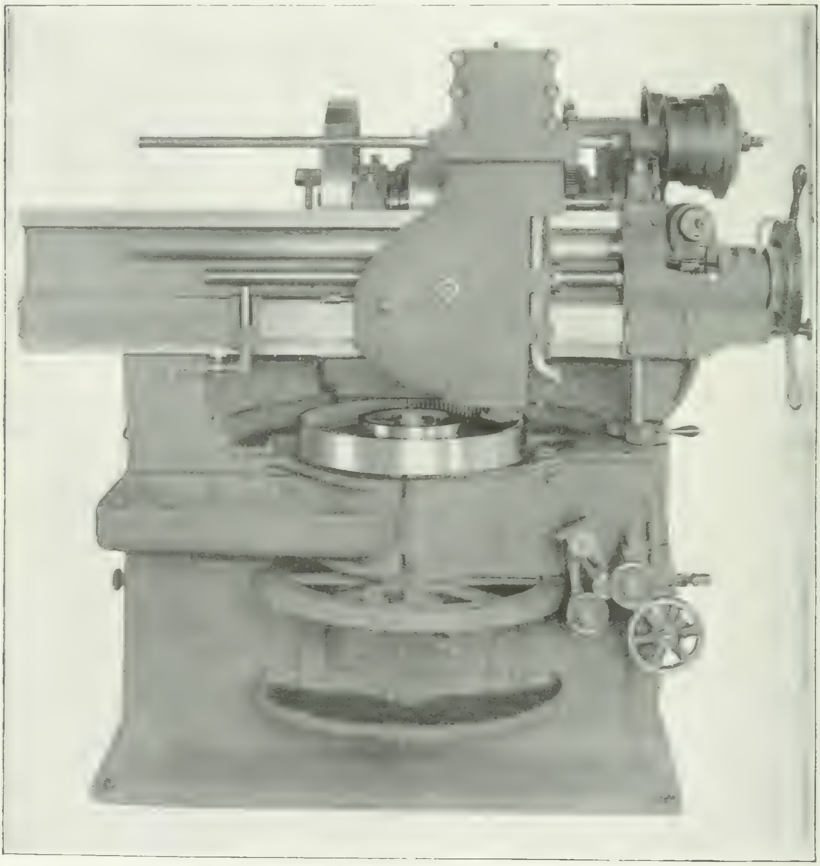
tained by steel tapes wrapped about a disk of the pitch diameter of the cutter blank. While the cutter blank is making its revolving movement, the emery wheel grinds one side of each cutter-blank tooth to correct form, one tooth at a time, until all are finished on one side; then the half-finished cutter blank is placed in a second machine, of the opposite "hand," and the remaining tooth faces are similarly finished. The resulting cutter thus becomes a gear, the accuracy of which depends only on the true flatness of the emery-wheel disk and on the perfection of the rolling motion imparted to the cutter blank. Perfect accuracy can be obtained in both of these fundamental elements, and the resulting cutter is, in practice, one of the closest known mechanical approximations to theoretical accuracy. Only one cutter is needed for each pitch used.

The mode of gear cutting is shown above. The cutter is reciprocated past the face of the stationary gear blank in a line of travel parallel to the blank axis, and the cutter is gradually moved toward



THE LOWER PINION IS CUT ON THE FELLOWS SHAPER, THE UPPER ONE ON THE ORDINARY MILL.

the blank until its teeth have entered the blank to the proper depth, the cutter teeth having a face or top "rake" of 5 degrees, as well as side clearance, so as to give precisely the action of a well formed planer or shaper tool, and the cutter being moved very slightly away from the blank during the idle down stroke, and moved back into true position during the upward cutting stroke. As soon as the full depth of cut is reached both the cutter and the gear blank are given the revolutions due to their relative pitch diameter, and the shaping continues until the teeth of the gear are all cut.



THE FELLOWS SHAPER CUTTING INTERNAL GEARING.

It is evident that by this highly ingenious procedure the teeth of each piece of gearing cut must be spaced with perfect accuracy, and must be given precisely the form required to coact with all other gears cut with the same cutter, no matter what the diameter may be, which are the two most essential features of gear-cutting perfection.

Not only does this machine produce really correct tooth forms of machine-cut gear teeth, but the thinness of the cutter and the consequent very small over-travel required make it much more suitable for many important classes of gear cutting than those gear cutters using mills of ordinary form, as is shown on page 96, where the lower pinion is formed on the Fellows shaper, and the upper one has the straggling "run out" terminal cut, inseparable from the use of the mill. For the same reasons the Fellows machine is particularly adapted to the production of internal gearing, as shown on page 96. This very valuable and often extremely desirable form of gearing has hitherto been avoided by machine constructors, who would have been glad to use it if it could be readily produced. This machine cuts internal gears as readily and rapidly as it cuts spur gears, and can cut up to within a small fraction of an inch of the gear arms or web by using the pushing stroke, and to within a short distance of the arms when using the drawing cutting stroke. It operates also with much less strain on the gear blank and much less wear on the cutter teeth than in the case of the mill, as it starts each cut with the full cross-section of the chip, instead of starting on nothing as the mill-tooth cut must start, and rubbing along without a cut for some distance after it should be at work, before sufficient pressure is brought to bear to force the cutter into the body of the metal.

The Bilgram bevel-gear cutter, the Barnes, of Rockford, Ill., and the Warren, of Hartford, Conn., both for bevel-gear cutting, and the Fellows gear shaper for cutting external and internal spur gears, and the Warner and Swasey machine adapted for cutting spur gears only, form the only examples within my knowledge of irregular surfaces geometrically produced by compounding simple axial movements. It is possible that other machines of this character are in use, and there are some surfaces, those of some rotary blowing machines, for instance, which might well be formed by similar methods. But, as mentioned at the outset, irregular surfaces which demand accurate repetitions are very rare indeed in machine construction, and except in the one important case of gear teeth do not cover a field of wide interest.

ECONOMIC AND LABOR FACTORS IN THE DISTRIBUTION OF INDUSTRIES.

By John Richards.

THE geographical distribution of the manufacturing industries in future is a new subject. Its origin is in the prodigious changes in implements, processes, facilities of travel and transportation, and especially in scientific methods and the aggregation of capital characterizing the last quarter of the nineteenth century. In the near future it must affect the national polity of the various industrial countries, establish new lines of trade, affect many social conditions, and determine investments in productive enterprises, now reaching a scale so vast as to destroy the value of precedents.

Until very recently the distribution of industries has been determined by causes mainly accidental, not admitting of generalization. Development was tentative, capital was invested on accomplished facts, and was not expected to assume risks. Industries were mostly small, isolated, and included a personal factor. These small industries are now disappearing. Mental, manual, and even commercial skill are no longer the sole basis upon which productive industries are founded. These are necessary, of course, and in a greater degree than before, but all kinds of skill have become a commodity to be purchased, regulated by rules qualified by science, and directed in new channels or even transplanted from one country to another.

The possibility of a successful manufacture of any kind in a particular place is no longer a matter of accident or of local skill, empirical knowledge, or the predisposition of a people. At least, all these things have become weak compared with commercial incentive in localizing manufactures. The main question is, Where is the greatest difference between the cost of production and market value?

There is no romance in industry. It is trade, and amenable to the laws of trade. Commodities are produced for the difference between what they cost and what they will sell for. In this commercial age—the era of craze for luxuries that money procures—one must assume a

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Mr. Richards' paper is especially interesting at a time when the "Trust" problem is undergoing so serious study. Sooner or later the futility of artificial restraints of trade will be recognised. Natural laws will assert themselves, in the economic as well as the physical world. The wise will not trust to the protection of a barrier which is certain to fall before the great forces of industrial evolution.—THE EDITORS.

purely commercial standard for all conjecture respecting the future distribution of industry.

With such a standard, admitting of computation and rule, it should not be difficult to predicate with tolerable certainty the circumstances under which future investments in industrial enterprises are likely to be made and the countries where certain industries will have their center and principal development. I say *future,* because in the past, as already remarked, the distribution of industries has been mainly from accidental causes of a local nature that would wholly fail at this time to produce the same results.

The heavy and dangerous processes—the heroic branches, they may be called—we find centering among the vigorous, unimaginative Anglo-Saxon people; the lighter class of products, involving imaginative traits, among the Latin races. This is equivalent to saying that accidental causes strong enough to found steel making in England would fail to do so in France or Italy. The making of porcelain wares at Dresden and Sevres, or of tapestry at Gobelin; diamond cutting at Amsterdam and wrought-silver working at Genoa; cloth weaving in Northern England and earthenware manufacture in Staffordshire—these are examples of the distribution of certain manufactures in which the principal component is local and even inherited skill. These industries have their origin to some extent in the predisposition of the people, but more largely in accident. There is no economic or commercial reason for such distribution; the causes were accidental, widely varying from what we can reasonably expect in the future.

It is not contended that all industries have been founded in this manner, but it is true of most of those in which skill is the principal component. In some cases this skill was progressive, inventive and changing, in other cases static or inherited. The writer once saw a workman with a simple tool cut external and internal screw threads on wooden screw faucets in a common lathe, using the tool by some peculiar sense of sight or touch to produce a true corresponding pitch for the screw and its matrix. In answer to an inquiry the man said: "I learned it from my father. It is easy enough"; but no one else could do such a thing without long training and the habit born of continual practice.*

Impediments to transportation, now to a great extent removed, have localized certain industries demanding heavy material and fuel.

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* Screw threads are cut by "chasing" tools in metal working, but this is a different matter. The pitch is arrived at by experiment, tentatively, and is aided by the tendency of a multi-pointed implement to produce the pitch. In wood the threads are cut at one motion and the pitch is attained by some mysterious sense of the workman.

Others, consuming a great deal of motive power, have been centralized around its sources, either water power or cheap fuel. These causes must continue to act in future, but with diminished value. Many new conditions—cost and celerity of transportation for one thing—complicate even the apparently simple problem of the influence of motive power and contiguous material. English coal may be cheaper on the eastern side of the German Ocean than in the cities of England near where the coal is raised; pig iron may be cheaper in South American ports or at San Francisco than on the Atlantic seaboard, by reason of unbalanced freight and inward ballast loading; but in all these things there is a rule and method quickly discerned by those who invest capital in manufactures.

Among the components of industrial production none is so flexible and transferable as skill. The means of travel are so complete and the habits of environment and association are so easily broken off and renewed, that within a country having a common language and habits it does not matter much where skilled labor is required, it will soon concentrate at any point. We have continual examples of this at the present day, but only a short time ago if one wanted to conduct a skilled industry he must go to districts where the required skill was concentrated. The influence of localized skill yet exists and will continue, no doubt, but only in a weak degree except in some of the most difficult branches of manufacture and especially in the small and steadily lessening number but little affected by machine processes.

The founding of cotton manufactures at Bombay, India, and at Nagasaki in Japan shows how completely local skill is ignored when countervailing conditions are favorable. The use of unskilled labor in such cases is possible only in connection with machine processes. The effect of the machinery is not only to supplant manual skill, as is commonly supposed, but to establish a "rate of working." As a rule, the product of cheap labor is in proportion to the pay—or is less, when a rate is not enforced by machines. A machine attendant in Bombay has to do nearly the same work as one in Manchester, Lowell, or Rouen.

Industry can be divided into two classes; one involving special and progressive skill with constant change, such as the production of implements, instruments, and machines, the second producing articles of uniform character in which the quality is measurably fixed and invariable, such as cast and fibrous metals, pottery, and so on. In this latter class of industries the element of special skill may nearly disappear, and success may depend on economic conditions alone; in the former, success may depend upon excellence of design and adaptation, independent of price. The money value of a cargo of iron, timber, or cloth, is determinable by the markets, but that of a cargo of machinery is not. This has a different standard of comparison. So it is with the causes distributing the production of these things; they also vary in their effects.

At this time a large quantity (about half a million of dollars' worth each month), of certain kinds of machine tools for metal working are being exported from the United States to European countries where the same machines can be made at a less cost for material and expense and perhaps, though it is doubtful, at less cost in labor. The reason for this trade in machine tools is not difficult to discern. It is a matter of skill in design and adaptation, joined with an organized and duplicated production, the latter enabled by an extensive and homogeneous home market that permits duplication or "manufacture" instead of "making." The cost of production is in this manner wonderfully reduced, while the efficiency and advantages of design have added to the price of American machine tools enough to transport and sell them profitably in Europe.

It is a peculiar branch of skilled industry to which the best skill is directed in all countries. These alone, among implements, produce themselves—that is, the machines are directed to the same processes that produce them, a thing not always thought of and one that lends a distinct feature of the trade. But to be permanent in future this trade must conform to certain inexorable conditions. Either the cost of their production must be less in the United States or their design and adaptation must be kept in advance. Considering the mobility of skill, the ease with which it flows from one place to another, and the widespread dissemination of descriptive technical literature, it is not reasonable to assume that this manufacture will remain an exception; it must in the end settle down to the lines of least resistance, that is, to the lowest cost of production. We can see signs of this in works of great extent and with the best possible equipment recently founded in Germany for producing machine tools on the American system.

Down to ten years ago the conservatism of practice in Europe and the want of the present widespread information formed a strong protection for American specialties in skilled production which found their way to European markets. American machine tools could be found in most parts of Europe, beginning with the small-arms factory at Enfield, in England, where many machines were furnished about forty years ago; but being demanded in small quantities and in special cases they found a market only in unexpected places. This sporadic trade has now become extensive and is crystallizing into commercial competition. To maintain it, attention will soon have to be directed less to design and adaptation and more to the cost of production.

It was an early recognition of this principle that gave to Great Britain and her colonies at one time 49 per cent. of the commerce of the globe and extended her sway over nearly a fourth of the commercial world. This was not done by her internal industries alone, but by great wealth derived from an opposite policy in other countries where heavy imposts were levied on trade. The British bought out the subsidized industries and sent the subsidy to London. The French marine subsidies are a case in point. There is no doubt that the greater part of the vast sum paid yearly by the French government for building and operating vessels finds its way to England. Hundreds of millions of British capital are invested in various branches of industry in the United States to profit by a system that diverts American impost taxes to London. When the Swedes began making lucifer matches, paraffined and without sulphur or phosphorus, the great firms in London who had previously controlled the trade did not set about schemes to compete. They simply bought up Swedish works to an extent that supplied the trade, and continued to operate them.*

A tax on products of skill will perhaps find its sequel in international combinations among producers; but whenever this results the distribution of industry in various countries will be amenable to new laws—the inexorable laws of money and gain. Production will flow to the points of least resistance, and all local schemes for controlling industries must go down in the face of a commercial power that will ignore personality, patriotism, skill, and all kinds of individual effort. Without international combination, the control of prices for manufactured commodities is limited by those of the open market plus the impost taxes; but such limitation is not enough to satisfy its beneficiaries, as we can now see in the case of a proposed combination of the shipbuilding interests, now protected in the United States by "prohibition of imports." Ships are about the sole thing that cannot be purchased and imported by the people of the United States, and consequently they afford a fair example to show how far the idea of combination has pervaded the industrial world.

The struggle to maintain national industries by means of impost taxes on home consumption, sending the surplus into the neutral markets of the world, cannot last long in this commercial age when, as now seems probable, industrial combinations will soon become international. Except in a few cases, corporate combinations have been content with controlling the domestic markets of their own countries by imposts and other means of discouraging consumers from purchasing in foreign markets, but anyone can see how this policy is weakening. The enhanced cost of all the components of production, due to augmented prices, raises the domestic cost of commodities above the world's standard, or above that of the neutral markets, so nothing is gained and foreign trade becomes possible only by discriminating prices between the home and foreign purchaser.

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* A fact, pertinent to the present subject, occurred about the same time respecting the trade in matches to Japan. That country had been supplied by Sweden, but when the trade began to be contended for by the English manufacturers of "Swedish" matches a few workmen and machines sent out to Japan soon settled the matter. I am informed that Japan does not import matches now.

Under the distribution of industry such as will result from industrial combination and the expansion of carrying facilities the United States will beyond doubt have an enviable place—if the impost and navigation laws are modified to permit free exchange. In manufactures of metal and wood the natural resources are such that nothing but artificial values, and the instability caused by impost taxes, can prevent a first place in the markets of the world.

Shipbuilding, the distribution of which in future has recently called out a symposium of views in one of the leading English technical journals, will be an exception to other industries because of the construction of war vessels by and for goverments. The construction of commercial shipping is perhaps the most important of all the skilled industries and is a prize to be contended for among the nations. It reacts with wide influence on other industries and on the commercial polity of a country, and in future no doubt will be separated from the construction of war vessels and will follow the line of least cost.

In war vessels the circumstances are different. We have seen this industry center in Great Britain, partly by the influences of skill, but mainly because there has been a long era of peace in that country, a commercial policy that did not interfere with the industry, the greatest skill, prestige, and the lowest price for material. Most of these conditions will continue. It will be a long time before other countries will shift the incidence of taxation so as not to affect the value of material and other components entering into shipbuilding.

The natural price of extensively used commodities, when not interfered with by local circumstances, has become in a measure uniform. By natural price is meant the value fixed by the cost of production. All products have such a price, although it is common to hear it said that prices depend on demand and supply. So widely is this believed that the saying has become an axiom. Yet it is a fallacy. A commodity never offered for sale, and for which there is no demand, must have a price. Such price—the natural one it may be called—is based upon the cost of production, as every one may see if he will trace out the genesis of prices. The "fluctuations" of prices are caused by demand and supply, and are unhealthy just in the degree that the demand price varies from the natural one.

In computing the cost of industrial production, it is common to estimate the labor component on the basis of a time rate, or per diem wages, without taking into account what the wages produce or what they will purchase in the country where earned. That this is fallacious goes without saying. Every carefully made investigation goes to show that the "rate" of wages is not at all a measure of the amount of wages that enter into the cost of producing.

As before remarked, the division of processes has ever been a characteristic of American skilled industry, and has in many cases diminished the labor cost of commodities below what could be attained in Europe even where the daily rate of wages was only half as great. Twenty years ago, the time rate of wages for making watches at Geneva was only a fourth as much as at Boston; yet the Boston watches had a lower labor cost. The difference is less now. At the same time a like but less difference existed in locomotive making. At the Baldwin Locomotive Works, in Philadelphia, 6.25 men made one locomotive in a year; at Berlin, in Germany, it required 13 men, at Paris 14 men, at Creusot 13 men, and at Crewe, in England, 11.5 men. The labor rate, it may be remarked in all these cases, is approximately inversely as the number of men; that is, is much the same measured by the product.

The wages of skilled labor are, in fact, a simple matter if divested of the sophistry thrown around the subject by confounding the "rate" of wages with the "amount" of wages, or, in other words, estimating wages by time instead of product. To make this plain one has only to confine the investigation to the practical conduct of any industry.

The part that trained skill may have in influencing the distribution of industry in future is not difficult to foresee. Its migratory character has been noticed, and this feature is all the time becoming more prominent as intercourse between countries becomes more intimate and extended. In a country geographically isolated as is the North American continent, and one that has applied not only the energy of its own people but absorbed it from other lands, people are not apt to realize how far the dissemination of skill has progressed in the older countries. This is especially true of Great Britain. Her artisans go to all parts of the world. So do the Swiss, Germans, and Scandinavians, and of late years a great many American skilled workmen have emigrated to other countries, following their peculiar implements and founding advanced manufactures in special branches, in watch manufacturing in Switzerland for example.

There is not only emigration of skilled men to equalize the producing power in different countries; there are also internal causes at work tending to equalize advancement. To show how unstable are differences between countries in respect to industrial skill, people now living can easily remember when Germany was not classed among countries advanced in industrial production, nor even among those which competed in the neutral markets with products of skill; but twenty-five years have wrought a revolution. The elaborate system of technical education that, forty years ago, began in Germany and for a long time was considered an impractical method of reaching industrial production, because not supplemented with the manual skill and empirical elements existing in some other countries, now turns out to be foremost in exploiting trade in remote markets. Technical and scientific knowledge became plenty and cheap in Germany. It overflowed into all parts of the industrial world, soon gathering the art of practical manipulative processes and of making implements therefor, so that Germany, with a paucity of local resources in fuel, metal, and timber, stands fully abreast with her rivals. Education has done this work and forms a stable basis for it to rest upon in future. Her lexicographers have gone to Africa and compiled trade literature in the languages of savage tribes and have set at work various influences to promote sea trade. She has, without subsidies, greatly developed her merchant marine and in considering the future distribution of skilled industry Germany's share is a problem not easy to solve. As the skilled processes and implements of England, America, and France have reacted upon Germany, so has her educational system reacted upon these countries and others so that skill of head and skill of hand, with the organized system of industrial production, has become general, and is no longer confined to particular places as in the past.

It is reasonable to assume as a general rule that the permanence and stability of a manufacturing industry are inversely as the profits that arise from it, so long as such profits do not fall below a reasonable return upon the investment. There are, it is true, certain conditions which may seem to modify this rule, such as secret processes, patented implements, fictitious capital shares, and discriminating laws; but all these are temporary, and must sooner or later go down before international competition. Profits on manufacturing are the same as interest on investments—the rate corresponds to the risk, and is so adjusted by experience and obvious economic laws.

The risk, or as we may say the danger of supersedure, is inevitable in any case where the profits of a manufacture rise above the normal rates of invested capital when the manufacture is open to international competition. The business may last a decade or a lifetime, but the end is no less inevitable and it is this fact that in many cases controls prices. In the manufacture of calcium carbide, for example, which in ten years has fallen from fifty to five cents a pound, the price has followed the cost of production and been regulated by international competition. Had the price been maintained at a high rate in any country, the industry would have become unstable and been superseded.

Profit is a regular component of industrial production, as much so as material, labor, and expense, and exercises a like influence on the permanence of a manufacture. Where it is declared and open, labor disturbance will cease among intelligent workmen, who know as well as their employers that this component must be supplied as well as their labor. Profits are declared and known in many industries in England and in some in the United States, with the difference, however, that in England the earnings are usually made up by an authorized accountant as well as by the owners. There is this check upon the accounts of all incorporated share companies, and the effect of this provision has been a great aid in maintaining skilled industries in a country where labor is especially turbulent and exacting.

The conclusions to be drawn from the cited conditions affecting the future distribution of skilled industry, and from many more that might be added, all point to an open struggle for supremacy during the first quarter of the next century, modified and hastened by combinations, or trusts as they are called in America. Local skill, traditional practice, personality, impost tariffs, and other circumstances that have in the past built up and localized industries, must succumb. Practice in the skilled arts will be assimilated, and the industrial nations assume a new and advanced position in world economy.

The opposing forces to this new system are legislative restrictions and the organized labor interests. The former have failed to deal with the problem, and the latter have developed no line of procedure that promises successful opposition to either industrial combination or distribution. The subject is one now undergoing investigation at many hands, but gives no immediate promise of a solution.

EDITORIAL COMMENT

Mr. Burt's comparison of the Nicaragua and Panama Canal projects was prepared some time since. The adoption later of the mean-level dividing-lock system, as recommended by the *Comité Technique*, has simplified and greatly improved the Panama route. The Bohio dam becomes comparatively an insignificant feature ; the surface of the lake behind it will be only about sixty feet above the sea. A second small dam, at Alhajuela, confines a second lake, controlling and regulating the upper Chagres. On the other hand, the locks are differently arranged, being in two emplacements (Bohio and Obispo) on the ascent from the Atlantic and in three (Paraiso, Pedro Miguel, and Miraflores) on the descent of the Pacific slope.

Again, the former Walker commission is said to have recommended important changes in the Nicaragua route, which would involve changes of detail there. The results of the study of the United States Government commission, now examining the Isthmian Canal routes, may suggest further modifications of certain features. While these would involve considerable change of detail in an itemised comparison of the two projects, it is not conceivable that they would materially change the broad results of the comparison as to general advantages in feasibility of construction, ease of maintenance, cheapness, and convenience of transit.

The *prima facie* evidence in favor of Panama is extremely strong—and far more so because it is studied with absolute completeness and actually half completed. Nicaragua is a "project," pure and simple, and so far a project based far too much upon foundation little better than guess work. It has not yet received the endorsement of any engineering talent even approaching in character that which has completely approved the Panama route. It has never won the confidence of capital sufficiently to support any serious effort at construction. And this scheme, devoid of authoritative engineering endorsement, incapable of inspiring financial backing, the people of the United States are asked to adopt blindly, to give their verdict for hastily, before the evidence they themselves have ordered can be put in.

It is, as the *Railroad Gazette* has said, competent to suspect the good sense or the good faith of those who urge such a course. The country will stultify itself and dishonour its self-appointed advisers if it act before their report is presented. Every board which has gone over the ground has urged the absolute need of such complete study as the present commission is making, before an intelligent conclusion could be reached. A million dollars has been appropriated for this adequate study, and now frantic effort is being made to force a conclusion before the results can be presented.

The case should not be prejudged either way ; but the Panama Canal is at least an actual entity—thoroughly studied in every detail, fully endorsed as practicable by unimpeachable and impartial authority, closely estimated as to cost, half finished and fullly equipped for complete execution. The Nicaragua Canal is "three-quarters of a mile of * * dredging in the low swampy ground," about twelve miles of rails laid on felled trees, with an equal length of telegraph wire strung on standing trees, a once-dredged but since filled-up channel on the foreshore at Greytown —and a strong and persistent influence in the lobbies of Congress and the platform committees of the great political parties.

As indicated in the editorial note appended to the valuable article of Professor Stodola upon steam engine building in Switzerland, published in the last issue of THE ENGINEERING MAGAZINE, lack of time prevented the submission of the translation to the author for examination and revision. We are therefore pleased to place these columns at his disposal for the insertion of a few additions and modifications which have since been received from him.

Professor Stodola is of the opinion that notwithstanding the increasing demand for power in Switzerland, the steam-engine manufacture is likely to diminish somewhat in volume, with the increasing development of water power, and that much of the future business will come from export orders.

The peculiar arrangement of the cylinders in the Sulzer horizontal tandem compound engines, the high-pressure cylinder being placed behind the low-pressure, diminishes the influence of the heat in causing deformation of the working parts.

In this connection Herr Emil Mertz, of Basle, calls attention to the fact that his firm not only constructs engines from the designs of Mr. C E. Brown, but also builds compound and triple-expansion engines of his own design.

* * *

It has long been felt among engineers in the United States that the Patent Office has been a sadly neglected department of the government, and the recent expression of opinion of the American Society of Mechanical Engineers but calls attention to that which most of its members have known for a long time.

Notwithstanding the fact that the receipts are largely in excess of its expenses, the balance in favour of the office being more than $5,000,000 in 1899, business is hampered and delayed by reason of an inadequate force of examiners, insufficient space for work, and a general lack of proper facilities. The library is by no means what it should be, and even such as the collection is, it cannot be used to advantage because of the contracted quarters in which it is housed.

It must not be forgotten that the records of the Patent Office constitute the legal evidence of title to a most important portion of the property of many great manufacturing establishments engaged in the production of patented articles. Many of the important suits in the United States courts deal with the rights of patentees and their assignees, and yet the records of this great industrial department of the government are neglected, in a manner which should cause the persistent demand of the whole industrial community for its remedy.

* * *

It has generally been supposed that technical and scientific societies were formed for the purpose of disseminating as widely as possible the latest and most reliable information in the various departments of work to which they belong, and in most cases this is true. Papers are printed in advance and distributed to the membership and also to the technical press, and usually the only limitation placed upon republication is the requirement that reprints shall not be made until after the communications have actually been presented before the organisations for which they were prepared. There are, however, a few societies on each side of the Atlantic which still adhere to the policy of declining to give out advance copies of their transactions to the technical press, and even forbid full reprints after the public presentation of the papers. Such action can do the organisations themselves no good, and can in the end only act to repress the presentation of really valuable papers, authors themselves always preferring to reach as wide an audience as possible; while the effect upon the technical journals is rather to excite feelings of sorrow that the ancient idea of the exclusiveness of knowledge still has a few followers in the midst of the modern appreciation of the great truth that "there is no darkness but ignorance."

REVIEW OF THE BRITISH PRESS

Railway Communication with India.

THE general development of railway enterprise in various parts of Asia lends interest to the paper of Mr. J. M. Maclean upon new projects of railway communication with India, recently read before the Society of Arts, and published in the *Journal* of the society.

Mr. Maclean begins by referring to the history of trade with India from the time of Marco Polo and the overland caravan route, down to the discovery of the route around the Cape, and the opening of the Suez canal, showing how the wealth which flowed into Europe from trade with India has influenced the course of commercial and political events in all parts of Europe.

The opening of the Suez canal permitted other nations than England to compete for the Indian trade and has seriously reduced the profits formerly controlled by England.

"Now it would appear that a new economical and commercial revolution is impending, and that maritime commerce is threatened with serious competition from the new trans-continental railways which Russia, in particular, is constructing with so much energy and foresight across Asia."

The completion of the Siberian railway and its connections to China will flood Asia with Russian and German commercial travelers, and a great proportion of the traffic which is now conducted by sea will be transferred not only to the overland route, but to the hands of England's competitors. The plans of Russia are not limited to the Siberian railway. A branch from the main line has been projected and surveyed which will extend from Orenburg to Samarcand, this completing, by a junction with the Trans-Caspian railway, the iron girdle with which all central Asia will be embraced by Russia. This will offer a tempting opportunity for the further progress of the railway through Afghanistan to Peshawur, and for that linking-up of the Russian and Indian railway systems which would reduce to nine days the journey from London to Calcutta.

The engineering difficulties in the way of this work are not great, and it would involve nothing more than the construction of a very few hundred miles through the passes of the Hindoo Khoosh and the Himalayas. It has been suggested that a better route would be by an extension of the branch of the Trans-Caspian railway now open to Kushk to Chaman, below Candahar, which is the terminus of the Indian railway system This line, however, would debouch into India at its extreme western limit, and would be complicated by the break of the Caspian Sea, across which passengers and goods must be conveyed by steamer. The line through Orenburg, on the contrary, furnishes unbroken land communication from Calais to Calcutta, and avoids both the Caspian and the sea of Aral, and possesses unquestionable advantages over any other that can be named.

It does not appear that England's oversea commerce with Bombay can ever be seriously interfered with by railways, but there is competition to be feared from a through land-line from Calais to Calcutta, which would enter India near its centre, and be continued down the great valley of the Ganges.

All these railway projects afford evidence of the immense commercial activity now spurring on both Germany and Russia to new enterprises. The rivalry of Germany has become generally appreciated, but less heed has hitherto been paid in England to the prodigious industrial and trading development that has taken place in Russia. It is generally assumed that the Trans-Siberian railway has been intended mainly for military purposes, but while that is largely the case, it is more correct to say that the commercial importance of the road holds the first place. The migration of Russian peasants to settle on the country opened by the new line has already begun, and a hard working agricultural population is settling down in what were the waste regions of Siberia. This emigration is encouraged and assisted by the government, houses, land, and implements being furnished free, and taxation for several years relieved, so that a permanent connecting link will be formed between Russia and Northern China, and an important trade ultimately be developed.

It is the idea of Mr. Maclean that the British government should secure its share of control of railway communication to India by joining with Russia to compel the Ameer of Afghanistan to permit the construction of railways throughout his kingdom. Everything is ready for an extension of the Indian railways from the terminus at Chaman, on to Candahar, this work only being checked by the position of Afghanistan. If this connection were made, Calcutta and Kurrachee would become the seaports for Russian goods desiring an outlet on the Indian Ocean, and India would be able to conduct a large and lucrative trade in her own articles of merchandise with the Persian and central Asian markets. Any objection to the linking up of the Indian and Russian railways might be equally well urged against the connection of railways on the Continent of Europe, and no one would desire to disconnect the railway communication between Paris and Berlin because war may some day break out again between France and Germany. Preparations for war between Great Britain and Russia need not be more formidable if the two empires are no longer separated by a belt of neutral territory, if both Powers well understand that the first step beyond a fixed line is equivalent to a declaration of war. There appears to be no good reason why a different rule should hold between two civilised nations in Asia than in Europe.

The Standardisation of Electrical Plant.

THE paper of Mr. Percy Sellon, read before the Institution of Electrical Engineers, upon the standardisation of electrical engineering plant, contains many valuable points upon this much discussed subject, especially since it does much to clear up the objections which have been urged against any change in the present practice.

Mr. Sellon calls attention to the fact that repetition manufacture is as important a factor in successful competition as cheap labour, cheap material, and efficient management, and shows that it has been the adoption of standard designs and methods which has rendered the powerful competition which England is experiencing with Germany and America a possibility.

The cause for the difference in the practice of engineering in England and her competitors is largely due to the different position held in different countries by the consulting or designing engineer.

"According to American and Continental practice, the producer determines, in a large measure, the character of the plant employed by the user; while according to British custom the buyer very generally imposes upon the manufacturer not merely a specification of the ends which he wishes to attain, but the details of means by which he desires those ends to be achieved.

"This is due to the fact that under the American and Continental system producers largely secure outlets for their manufactures through the agency of powerful financial organisations created by and allied to their interests, who are concerned simply with commercial results, and are content to leave the technical means of attaining them to the manufacturing interests with whom they co-operate. In America these organisations take the form of colossal trusts or consolidations of competing interests; on the Continent that of industrial banks. In either case there is a close relation between producer and buyer.

"In Great Britain, on the other hand, the demand for electrical engineering plant in recent years has issued chiefly from local authorities, or from private users unconnected with any manufacturing interests; and these have very naturally had recourse to electrical engineers acting in a consulting capacity or passing permanently into their service, to guide them in the choice of plant to fulfil their requirements."

It is thus evident that in England the engineer is employed by the purchaser, while elsewhere he is employed by the manufacturer.

It is entirely natural that this difference in practice should result as it has. The manufacturer demands of his engineer that he should design work which shall not only be efficient in operation, but also profitable in manufacture, and standardisation follows as a matter of course. The engineer employed by the customer, on the contrary, makes his designs before it is determined by whom they are to be executed; and in any case rather prefers not to imitate or follow details of the practice of others.

At first sight it might appear that either method would produce good results, but there is one point of which sight must not be lost: the buyer's engineer has gradually overstepped the rational function of stating the ends or performance required by the buyer, and has proceeded to specify in minute detail the means or constructional methods by which the required results are to be achieved, without taking responsibility for the result.

When the engineer is responsible to the manufacturer, not only for the successful performance of the product, but also for the possibility of its economical manufacture, he is not apt to try too many experiments or to endeavour to infuse too much individuality into the work, but will retain well proven and standard methods and details, and in many cases bear in mind future uses to which various parts may be put.

It has been maintained that standardisation must act to retard progress and to prevent the prompt introduction of improvements, but experience has shown that the most rapid progress is made in those countries in which standard designs are most used, and it is evident that competition between manufacturers will always prevent any such stagnation. Retardation is much more likely to occur by reason of the multiplicity of designs and methods resulting from the exercise of unrestrained individuality.

Mr. Sellon makes a suggestion as to the best method of obtaining the benefits of standardisation without abandoning the services of the buyer's engineer.

"Assuming," says he, "that the buyer's engineer has come to stay, it would appear that a condition precedent to the standardisation of plant is the standardisation of the buyer's engineer.

"The initial obstacle to a greater measure of standardisation than at present obtains would be removed if the user or his engineer would confine himself to stating the ends he has in view, leaving it to the producer to furnish the means whereby they may be attained. If this procedure were adopted, users would still retain full liberty of choice between the products of different manufacturers, while the latter would have an opportunity (which under the present system of detailed specifications they do not enjoy) of undertaking repetition manufacture, assuming that they have sufficient confidence in the substantial harmony between their designs and public requirements to take the risk of quantitative production."

If there were any doubt as to the necessity of standardisation in Great Britain, it would surely be removed by an examination of the table appended to Mr. Sellon's paper, in which is shown the system, periodicity, generating pressure, and distributing pressure in the central stations of Great Britain. The entire absence of anything like standard practice, and the presence of trivial differences, will prove, if proof were needed, that great advantages might have resulted from a little harmony of action between designers and manufacturers.

Progress in Space Telegraphy.

The recent address of Mr. Marconi before the Royal Institution, while largely popular in its nature, is worthy of note as the latest account of the progress which has been made in space telegraphy, and hence a brief abstract is here made.

In the apparatus itself some important changes, or rather modifications, have been made, which appear to improve its action very materially. In the coherer the principal change has been the marked reduction in the distance between the terminals. The early coherer consisted of a tube several inches long, partially filled with filings enclosed by corks, but this construction was not altogether reliable. If, however, specially prepared filings are confined in a very small gap, say about one millimeter, between flat plugs of silver, a much more reliable instrument is obtained. The resistance of such a coherer is practically infinite when in its normal condition, but when influenced by the electric waves it instantly becomes a conductor, the resistance falling to 100 to 300 ohms, and remaining so until the tube is shaken or tapped.

The other improvement is also important. Instead of connecting the vertical and earth wires at the receiving stations directly to the coherer as formerly, Mr. Marconi now connects them to the primary of a small induction coil or transformer, the secondary of which is connected to the ends of the coherer, one of the connections passing through a condenser. The effect of this transformer is to increase the electromotive force of the induced oscillations at the terminals of the coherer, and to cause it to break down with a weaker oscillation than would be possible if it were connected directly to the vertical conductor. This renders it possible to communicate over much greater distances than formerly, a most desirable result.

Mr. Marconi discussed at length the peculiar windings which he found necessary for the induction coil used by him, showing that unless this matter was most carefully attended to no effect would be produced. The effect of the peculiar mode of winding, for which the reader must be referred to the diagrams of the original paper, is to prevent the effects due to electromagnetic induction from being in opposition with the electrostatic induction at the ends of the primary.

The later experiments have practically verified the correctness of the law previously announced as to the distance over which signals might be sent. This law is that the distance over which it is possible to signal with a given amount of energy varies approximately with the square of the vertical height of the wire, and with the square root of the capacity of the plate, drum, or other form of capacity area which may be placed at the top of the wires.

Many months ago it was found possible to communicate from North Haven Poole to Alum Bay, a distance of 18 miles, with a height of 75 feet. It has now been found that with wires 150 feet high communication can be effected from Wimereux, in France, to either Harwich or Chelmsford, the distance in either case being 85 miles. According to the theory, doubling the height of the wire should give four times the distance, or 72 miles, but it appears that the law is only approximate, and that the tendency is on the side of a slight excess in range. It is especially interesting to note that the height of the poles at the stations was but 150 feet, although it would have been necessary to have had vertical wires of over 1,000 feet in height for a straight line between them to have cleared the curvature of the earth.

Mr. Marconi made some remarks about the use of his apparatus in South Africa, showing that it was of little service, owing to the lack of provision of poles for the vertical wires, although some successful experiments were made with the aid of kites.

Predictions are always uncertain, but Mr. Marconi claims that the progress which will be made this year will greatly surpass what has been accomplished in the past twelve months, and maintains his belief that, by means of the wireless telegraph, telegrams will be as common and as much in daily use on the sea as at present on land.

The Quality of Steam.

In the course of an editorial discussion of the important subject of the quality of steam, *The Engineer* brings out some interesting points, especially in connection with superheating.

It is rightly claimed that not enough attention is given to the quality of steam produced by boilers in the ordinary course of power generation, but that in most cases it is moist, and in some instances it is very wet. Calorimeters are used during tests, especially if any requirement as to dryness of steam has been specified, but after that but little is thought of the quality of the steam, and unless enough water is carried over to cause trouble in the cylinder, but little attention will be paid to it. A much smaller quantity than that necessary to cause a breakdown may still do much harm. Piston rings may be broken, packing ruined, valves jammed, even by clean priming, while the dirty stuff which is carried over from some boilers is responsible for much cutting of valve seats and scoring of cylinders.

The most obvious remedy for wet steam is superheating, but this will not prove a complete remedy unless it is accomplished intelligently. It is not good practice to permit a boiler to prime freely and then obtain dry steam by providing an abundance of superheating surface. The superheater becomes a sort of auxiliary boiler, and works under all the disadvantages of a boiler with an insufficient supply of water. Unless the water is altogether free from lime and other salts there will be a deposit of scale in the superheater, and if the superheating is carried to a fairly high degree there will be formed, instead of scale, a fine hard dust of lime and iron rust, which will be carried along with the steam into the engine, scoring and cutting the valve seat and cylinder in a marked degree.

Excessive priming should be prevented by proper boiler design, ample capacity, and the use of clean and pure water, and the saturated steam thus produced then passed into a superheater to be given such a degree of excess temperature as will prevent to a great extent the losses due to cylinder condensation.

Instead of performing the superheating altogether before the steam enters the engine, it may, in the case of multiple-expansion engines, be done in the receivers. Live high-pressure steam, circulating in coils in the receivers, will provide dry or superheated steam for the intermediate and low pressure cylinders, and all the heat thus supplied from the boiler will be returned in the form of useful work, while the action of the steam in the later cylinders will be improved, and this method is now advocated by a number of successful builders. It has also been suggested that some liquid of a high boiling point, such as oil, might be used in a system of circulating pipes to convey heat from the boiler flues into the receivers, thus enabling heat which would otherwise be wasted to be used instead of employing live steam.

Whatever method be employed, there can be little or no doubt that clean, hot, dry steam is necessary if the highest economy is to be realised, and it may be accepted that the immediate practice of the best makers is tending strongly in the direction of fairly high superheating as a necessity. That this will involve some modifications in constructive details must also be admitted. Sliding valves, whether of the flat, piston, or Corliss types, are not well adapted for use with the hot dry gas, and poppet valves with lift and drop movement appear to be the most available. This has already been demonstrated in the analagous practice of internal combustion engines, and it is well-known that prominent builders are preparing to modify their standard designs with a view of rendering their engines suitable for use with highly superheated steam.

In discussing the highly economical results which have been announced as performances of engines operating with superheated steam, care should be taken to ascertain that all the costs properly chargeable to power have been included. If a separate superheater is used, the calorific value of the fuel burned in connection with it should be charged to the engine in computing the efficiency, and all steam supplied to jackets or receivers should be included.

As matters now stand it is very difficult to make intelligent comparisons of the performances of various engines, owing to the varying conditions under which the trials have been made, and the incompleteness of the data and results given to the public. It is to be hoped that the efforts of the committees of the Institution of Civil Engineers and the American Society of Mechanical Engineers, which have this important matter under discussion will result in the general use of methods which, while sufficiently flexible to permit of adaptation to all practical cases, will at the same time insure the determination of the data which may render the results in all instances consistently comparable.

Gas as Fuel.

The advantages of gaseous fuel have frequently been set forth, and in respect of cleanliness, convenience, and freedom from smoke it leaves nothing to be desired. The question of the economy of converting coal to gas in a producer and using the producer gas as fuel, should, however, be determined by a comparison of the results which would be obtained if the same fuel had been burned directly in a furnace. The method of making such a comparison is very clearly given in an article in a recent issue of the *Iron and Coal Trades Review,* from which an abstract is here given.

In the conversion of coal to gas in a producer an indirect or partial burning takes place, and this burning has generally been considered to occasion a loss of about one-third of the heating power of the coal, this conclusion probably being based upon the fact that carbon burned to carbonic oxide parts with 30 per cent. of its heating power. While this is true as to the fixed carbon in the coal, it is not correct for the volatile carbon, which, so far from losing heating power, becomes rather the absorbent of much of the heating power the fixed carbon loses.

In order that a fair comparison may be made, the action of burning coal in an ordinary furnace should be considered.

"Before the first appearance of flame can kindle on a piece of *ordinary* coal, heat must have been absorbed and work done upon that piece. This work is the liberation of gas and vapour out of its solid mass. The change in volume which takes place on the gas and vapour substances so liberated is very great. A single cubic foot of coal may yield several hundreds of cubic feet of gas and vapour, and this too while the coal to outward appearance is suffering no diminution of its own bulk. Such a change in volume in any body has a close connection with the amount of heat which must disappear in working the change. Of the whole substance of the coal there is usually about one-third, in many cases a good deal more, over which there passes this great change in volume. From this it will be seen than heat absorption on a scale too great to be overlooked has to be reckoned with in the combustion of a lump of coal."

When the combustion takes place in a producer it is that of the fixed carbon of the coal, burning to carbonic oxide, the carbon being dissolved away from its solid form into a fluid, combustible gas, only the incombustible ashes remaining. From the heat produced by this burning is supplied whatever part may be necessary to drive out the vapour and gas. Whatever moisture may be present in the air supplied is decomposed, but the heat absorbed in this action is restored by its subsequent recomposition.

Having considered these actions it is possible to make a comparison between the effect of the direct combustion of fuel with that produced by its conversion to gas in a producer previous to combustion.

As an example, Lanarkshire splint coal is taken as a fair representation of the common manufacturing coals of Scotland, and for 100 units, burned in an open fire grate, it is shown that there would result 548,733 calories, making deduction for the heat expended in expelling the gaseous matters. The same coal converted into gas is a producer, the gas being subsequently burned cold, would evolve 493,924 calories, thus showing a loss of but 9.98 per cent. by burning it as producer gas. Approximately similar results are obtained by taking an average of the coals of the whole United Kingdom.

When the coal contains very low fixed carbon and a corresponding high proportion of volatile carbon there would be no loss whatever in the conversion into gas, while for anthracite there would appear a loss as high as 25 per cent., or even more.

With such fuels as the shales the proportion of volatile carbon is so high that it would be entirely possible to mix a shale with anthracite in such proportion that no loss would appear by conversion of the mixed fuel to producer gas.

As it has been proposed to conduct the gasification at a sufficiently high temperature to fuse the ash to a slag, in order to prevent clinkering, and to facilitate the removal of the non-combustible, it is interesting to see that the computations show a loss of less than one-half of one per cent. of the full heating power of the coal for each 5 per cent. of earthy matter fused to liquid slag.

It appears then that in making producer gas with coal of average quality, the loss in heating power need not be much over 10 per cent., and that this 10 per cent. of loss may be wiped out by certain changes in the fuel.

The Functions of the Engineer.

THE address of Sir W. H. Preece before the Glasgow Association of Students of the Institution of Civil Engineers upon the subject of the functions of the engineer contains some excellent points which call for emphasis and comment.

After distinguishing the civil engineer, or practical man of peace, from the military engineer, or practical man of war, he goes on to show how far-reaching the scope of the work of the civil engineer may be extended.

"The success of the modern engineer is due to the fact that he has buried in the depths of oblivion the much vaunted empirical rule-of-thumb, and that he has elevated to the heights of science the observations of exact practice and the exercise of pure reason. The principle of doubt, which is the root of all scientific inquiry, forces him to consider every phase of weakness in the materials that he employs in his structures, to examine every possible cause of error in his designs, to anticipate every source of failure in his work."

As a result of this modern advance in the application of science to practice, the education of the engineer has become a matter of ever-increasing importance. The modern engineer is the outcome of high-class and long-sustained education, either imparted or self-acquired. Such an education is obtained not only by the study of books and the hearing of lectures, but also by the cultivation of the powers of observation, the systematic training of the memory, and the development of the exercise of thought.

Engineering has now become only another term for applied science, and in order that the engineer may properly fulfil his functions in the modern conditions of work he must know how to apply science in the truly practical form.

"The boy who has passed well through the ordinary curriculum of school, and proceeds thence into a university, from which be emerges as a young man not only well imbued with the refining influences of literature and art, but with a well-earned degree of science, is fully prepared to commence his engineering training and to enter the workshop or the drawing office, where alone he can acquire that combination of knowledge and skill, and that training of the brain and the hand for mutual aid which is called technical training.

"It is not a question between science and practice; it is a question between science and rule-of-thumb. Practice is always there, but rule-of-thumb means rule of error, until by repeated failures rule-of-thumb becomes rule of right, which means the victory of organised common sense. Organised common sense is a very good term for science. Scientific men talk nonsense when they observe differences between science and practice, and so-called practical men act foolishly when they ignore science and assert that an ounce of practice is worth a ton of theory. Practice based on true science means immediate success and economy; practice based on rule-of-thumb means error, delay, and excess of estimates. The engineer cannot neglect the laws of nature any more than the scientific man can ignore the success of practice.

"The civil engineer of eminence has not only to know thoroughly the science, but also how to conduct the practical operations of his profession. The lives of human beings are entrusted to his designs. People have faith in the safety of his ships, long tunnels, bridges, and railway trains. He is called upon to advise on policy, to deal with commercial management, to act as arbitrator or judge in many important judicial cases, and to appear in courts of law and committee rooms of Parliament as an expert witness. The mental qualities of the engineer must therefore be of the very highest order. His scientific training and his world-wide practice have broadened his views and enlarged his mind. Above all, his character must be above reproach. The honor of the engineer is the honor of his profession."

Aerial Propellers.

One of the most important questions in connection with aerial navigation is that of the resistance of the air, both as an obstruction to the motion of bodies passing through it, and when considered as an abutment for the reaction of propellers. The experiments of MM. Le Dantec and Canovetti were discussed in these columns several months ago (October, 1899), these relating to the resistance of the air to falling planes and to moving bodies in general, and now we have in *Engineering* the paper of Mr. William George Walker, giving the results of his experiments with large propellers.

The experiments, which were carried out during the latter part of 1899, with the expert and financial assistance of Mr. Patrick Y. Alexander, were made to determine the thrust or lifting power of air propellers 30 feet in diameter. The author had previously made experiments with propellers varying from 2 to 5 feet in diameter, and in a communication to the British Association at its meeting at Bath, in 1899, he showed that for tip speeds up to 15,000 feet per minute the thrust varied as the square of the speed, and the horse power varied as the cube of the speed. Making some allowances for experimental errors, these laws have been followed in the case of the 30 foot diameter propellers.

In the report of the experiments made to the Royal Society, from which the author had also been aided by a Government grant, the apparatus is very fully described, and only a condensed account of it can be given here. The propellers, of which there were several tried, were mounted on a horizontal axis at the end of a room 68 feet wide, 60 feet high and 210 feet long. The propellers were arranged to be driven at various speeds by a portable steam engine, the thrust being measured by a dynamometer, while indicator diagrams showed the power developed by the engine. The construction of the propellers was peculiar in that, although there were four blades, these were arranged in pairs, parallel to each other, but separated by about three feet in order to permit of a lattice framing to be used, and thus obtain the necessary stiffness. In general appearance the construction resembles the Mangin screw propeller, and the framework being made of steel tubing, with a covering of canvas, both stiffness and lightness were secured.

The general arrangement of the apparatus was such as to give ample room for the proper circulation of the air, and the apparatus was carefully calibrated, in order that all possible errors might be corrected or eliminated. Each propeller was tested at about 10 different speeds, varying from 20 to 60 revolutions per minute, and the results were tabulated by plotting the experimental thrust and drawing curves through the points thus obtained. In this way it was thought that irregularities due to unavoidable errors of experiment would be corrected, and a fair average series of values obtained.

Taking the experiments as a whole, and making allowances for experimental errors, the following relations were verified:

1. The thrust varies as the square of the revolutions.

2. The horse power varies as the cube of the revolutions.

3. The thrust per horse power varies inversely as the revolutions.

"In the design of suitable lifting propellers for aeronautical purposes there are many practical and theoretical points to be considered. For instance, it would not be economical to arrange for too high a thrust per horse power, due to consideration of the weight of the propellers. Taking into account the weight of the propeller, there is a particular thrust per horse power which will give the highest efficiency." By use of the data derived from these experiments propellers of other sizes, and even somewhat different design, may be proportioned, and the thrust and horse power be approximately arrived at for any particular speed.

The resistance of the propellers may be divided into two kinds, that due to the skin friction of the surface, and that due to the framework structure of the propeller. The skin friction can be reduced by diminishing the width of the blades, the loss being nearly halved by making the blades one-half the width, and this also reduces the resistance due to the framework. The resistance of the structure is mainly due to the portion near the tips, where the velocity is greatest, the presence of struts in the central part absorbing comparatively little power. It is therefore desirable to make the structure as light as possible at the tips, where wire may be used to advantage for strengthening the frame. The surface friction can also be reduced by making the material of the blades as smooth as possible.

While it is by no means certain that the use of lifting propellers is the best method of attacking the problem of aerial navigation, yet it is very probable that in one form or another they will be important adjuncts, and the experimental data thus determined by Mr. Walker's experiments form an important contribution to the limited stock of information upon the subject.

REVIEW OF THE CONTINENTAL PRESS

The Railways of Africa.

THE present interest which attaches to everything relating to the development of Africa renders the article by Herr H. Claus upon the railways of Africa, appearing in a recent issue of *Glaser's Annalen,* especially timely, and a rather full abstract is therefore permissible.

Herr Claus first discusses the political condition of Africa, showing that apart from the three small republics of the Transvaal, the Orange Free State, and Liberia, and the two native states of Morocco and Abyssinia, the whole of the continent, with its 11,584,000 square miles area and 140,000,000 inhabitants, is under the rule of various European nations. It is estimated that seven-eighths of the area and nine-tenths of the population have come under European control, the greater portion of this being governed by England. Broadly, the British portion includes the Nile valley, the territory from the Cape to Lake Tanganyika, the island of Zanzibar, and the sources of the Niger; an area of nearly 3,700,000 square miles, with a population of 58,000,000. The portion controlled by France includes Algiers and Tunis, the country about Lake Tchad, the fertile Congo basin to the upper portion of the White Nile, also the territory between Abyssinia and Bab-El-Mandeb, and the Island of Madagascar; a total of nearly 3,000,000 square miles, and a population of 27,000,000.

The third in point of magnitude includes the territory controlled by the King of the Belgians, the Congo State, 865,000 square miles area and a population of 25,000,000; followed by the German possessions, which are in three groups, Togo and the Cameroons in the West, the large area between the mouth of the Kunena and the Orange river in the Southwest, and in the East the territory from the Indian Ocean to the great lakes; the whole number being about 861,000 square miles area, with 6,000,000 population. The Portuguese possessions include Delagoa Bay, the Mozambique coast, and the lower valley of the Zambezi, on the East, and on the West the province of Angola, the area being 849,000 square miles, and the population about 4,500,000. Italy possesses the territory of Massowah, on the coast of the Red Sea, with an area of 400,000 square miles, and a population of 2,000,000, and Spain controls a similar territory of the Atlantic coast south of Morocco, with an area of 212,000 square miles and 500,000 inhabitants.

The development of railways in all these territories has thus far been small, but many projects have recently been made public and a considerable portion of the work executed.

Starting from the French colonies of Algiers and Tunis in the north west, and following around the coast we find short spurs of railway extending into the interior, this being the most natural way of opening up the interior of such a continent. In Algiers and Tunis there were, at the close of 1897, 2,475 miles of railway, of which 2,150 miles were in Algiers and 325 miles in Tunis, in which latter colony 560 miles were also under construction. In Senegal there is a coast line from St. Louis to Dakar, a distance of 164 miles, and in the French Soudan the line from Kayes to Tulimandio, a distance of 335 miles, connects the upper navigable waters of the Senegal with those of the Niger, this connection greatly strengthening French power and influence in the western Soudan. A number of projected roads from points on the Guinea coast to interior towns are among the plans for the development of this portion of the coast, while the great project of a Trans-Saharan railway, extending from Algiers and Tunis down to Lake Tchad and to the navigable waters of the Niger, is well-known.

The Congo is navigable as far as Matadi, above which point the rapids known as the Livingstone Falls prevent navigation for a distance of 186 miles. Above these the Congo and its tributaries form a network of navigable streams of more than 9,000 miles in total length. The Congo

Railway Company has constructed a railway extending 236 miles from Matadi to Dolo, on Stanley Pool, this road, which was opened in July, 1898, taking the place of a difficult path by the falls, the journey over which formerly occupied 20 to 30 days. Plans for other railways in the Congo State have been discussed, but these have not yet taken definite shape.

In the Portuguese colony of Angola there has been under construction since 1888 a railway extending from Sao Paolo de Loando, on the coast, to Kasange, on the Kwango, a tributary of the Congo; nearly 200 miles of this road being now in operation, and other railways are projected in this colony. There has also been some discussion about a railway connecting the colony of Angola with the Portuguese possessions at Mozambique, on the east coast, but such a road would necessarily pass through the British territory of Rhodesia. Since the work is practically in the control of British capital and the construction undertaken by British labour, this point offers no insuperable difficulty, and the line now under construction from Mossamedes to Huilla is to be prolonged through Rhodesia and connected with the completed railway from Beira to Salisbury. It is also reported that an agreement has been made between England and Portugal for the construction of a harbour at the mouth of the Kunene, and the building of a railway from thence eastward to Buluwayo. In German southwest Africa a railway is being constructed by the German government to extend from the mouth of the river Swakop to Windhock, and 60 miles of this road have been in operation since April, 1898.

The most important portion of the railways of Africa, however, are those in the British Cape Colony, the Orange Free State, and the Transvaal Republic. These have a total length of 4,350 miles, the main western line extending from Cape Town to Buluwayo, and beyond to Salisbury, where it connects with the Portuguese line from Beira. Branch lines also connect with Port Elizabeth, Port Alfred, and Port Natal. Johannesburg and Pretoria are connected with the Indian Ocean by two railways, one running to the Portuguese harbor of Lourenzo Marquez, and the other to the port of Durban, in the British colony of Natal.

It is connection with the Egyptian railway up the Nile valley from Alexandria to Cairo, and beyond to Khartoum, that the proposed Cape-to-Cairo route has been considered, the whole being intended to form a mixed rail and water route through the whole length of the continent. A full discussion of this project is given in another place in this issue, and hence only a brief reference to it is here necessary. Herr Claus gives a detailed tabular statement of the length of the various portions of the route, his map showing very clearly the completed and proposed portions.

In British East Africa, an important piece of railway is being constructed from Mombassa to Port Victoria, on the Victoria Nyanza, this road being more than 600 miles long, passing over an elevation of more than 8,500 feet, north of Mount Kilimandjaro, and when completed it will enable direct communication to be made from the 25,000 square miles of area of the Victoria Nyanza to the sea.

At the beginning of 1899, 125 miles of this road were in operation.

Herr Claus discusses briefly a number of minor projects for railways from points on the coast into the interior, all of which are of interest in connection with the general opening up of the continent, but for further information respecting these reference must be had to his excellent map and article.

The Electrical Operation of Lock Gates.

SINCE 1896 there have been under construction at Ymuiden, in Holland, at the mouth of the Nordzee Canal, several new locks, which, with the mechanism for operating the gates, form the subject of an interesting paper in the Transactions of the Royal Institute of Engineers of the Netherlands, published also in the *Zeitschr. des Oesterr. Ingenieur und Architekten Vereines.*

The new basin, now completed, is 220 metres long, 10 metres deep, and 25 metres wide, and is connected with the outlet by a canal divided into two sections, forming auxiliary basins of 240 and 70 metres long respectively. This involves three sets of lock gates, the middle set acting as a reserve in case of accident, and each set consists of four gates, two for the flood and two for the ebb tide, thus making 12 gates in all.

The gates are made of steel, with double walls, so arranged that water may be admitted to provide the proper ballast, the weight being from 120 to 140 tons, and as these require to be opened and closed promptly and to be at all times under perfect control, the question of operative power had to be considered. In order to decide the selection of motive power a competition was arranged, the result of which was the submission of 13 designs, of which 1 was pneumatic, 8 hydraulic, and 4 electric. None of these appeared to be exactly satisfactory, but 2 electric and 2 hydraulic designs were purchased, and applied experimentally upon smaller gates, in order to furnish experience for the larger installations. As a result, an improved electrical design was made and has now been put into satisfactory operation.

One feature which rendered the use of electric power desirable was the distance separating the several sets of gates. This would have involved the use of long systems of high-pressure hydraulic piping, or three separate pumping plants, while in the case of electricity the current can readily be transmitted to all points. An electric plant is also necessary for lighting purposes, so that the whole power plant can be concentrated and operated to the best advantage. There were certain disadvantages in regard to electricity, as well. The rapid motion of the motors had to be converted into a slow, steady movement suitable for controlling such heavy masses; also the switching devices, especially in connection with automatic operation, became somewhat complicated; and the great enemy of electricity, dampness, was everywhere present.

Each gate is operated by means of a long connecting rod, attached at about the middle of the width, the inner end of the rod being connected to a traveling carriage to which motion is given by four endless chains passing over sets of sheaves. The chain-sheaves are operated by a train of gearing driven by the electric motor, the speed being reduced by a worm-wheel and pair of worms. In order to avoid shocks, strong springs are interposed at the connections of the chains with the carriage, and a friction connection is included in the gear train, which permits slipping if the stresses exceed a predetermined limit.

The motor in each case is placed in a separate chamber from the rest of the mechanism, this room being carefully cemented to prevent the access of moisture, the motor shaft passing through a fitted bearing in the wall, and there being three doors in the passage communicating with the chamber containing the operating gearing.

There is one 45-horse-power motor for each gate, and it is required that this shall open the gate in 1.5 minutes, against a difference of level of 10 centimetres, the motion being automatically arrested at each end of the travel. In addition to the mechanism for operating the main gates, the by-pass gates by which the lock chambers are filled and emptied are operated electrically, the whole being under the control of a single operator. The whole arrangement, including the connections, electric brakes, and wiring, appears to be remarkably well adapted to the peculiar conditions of the service, and it is probable that this installation will lead to the application of electric power to canal and reservoir locks elsewhere. The power station for the plant contains two steam-engines and dynamos of 100 h.p. each, besides a large storage battery.

The Progress of Electrochemistry in 1899.

THE constant growth in the industrial applications of electrochemistry and its importance as a commercial branch of electro-technics renders the review by Dr. M. Krüger of the progress made during 1899, a subject well worthy of review and notice, and from his paper in the *Elektrochemische Zeitschrift* some of the salient features are here abstracted.

An account of the various theoretical investigations which have been carried on during the year is included in the paper, but only those studies having a direct practical bearing are appropriate to these pages. Among these may be noted the work of Gross upon the relation between the electromotive force and chemical heat generated in galvanic elements, according to the theory of Helmholtz, and the studies of Platner upon the dissociation theory. The studies of Foerster upon the electrolytic production of chlorates have also been valuable contributions to an important practical department of work.

In the department of the generation of electricity there has been a continuance of the efforts to make a more economical primary battery, and the battery of Wischnegorsky, consisting of cobalt and tin in a solution of bichromate of potash acidulated with sulphuric acid, and the element of Exner and Paulsen, using zinc and superoxide of lead in a mixture of dilute sulphuric and oxalic acids with gelatine, are the latest contributions to the list.

There has naturally been more attention directed to accumulators than to primary batteries, most of the efforts having been toward the improvement in details rather than in any radical change. The improved plate of Borntrager may be mentioned, this consisting of spongy lead formed under heavy pressure into a cellular shape, the edges and cross strips being subjected to a pressure of 100 atmospheres, while the intermediate portions receive only 5 to 10 atmospheres pressure. The investigations of Cahen and Donaldson as to whether it is better to charge a battery under constant current or constant pressure, have shown that with constant pressure the charging is effected in a shorter time and the discharge takes place at more uniform pressure, but that the efficiency is higher when the battery is charged with constant current.

The department of electro-metallurgy and galvanotechnics naturally forms the most important branch of electrochemistry, especially from the standpoint of the engineer, and in these lines of work material progress has been made during the past year. There has been but little noteworthy accomplished in the line of wet electrometallurgical processes. The method of Cowper-Coles for obtaining zinc from sulphide ores consists in conversion into sulphates and oxides by roasting, followed by leaching with very dilute sulphuric acid, the zinc and copper going into solution. The metals are then separated by electrolysis, using anodes of lead, and disk shaped cathodes of iron.

In galvanotechnics a number of interesting processes have been developed. According to the experiments of Foerster, tough copper is deposited electrically if a 20 per cent. acid sulphate of copper solution is used, a temperature of 40° being maintained and a current-density of 1 ampere employed. Improvements have also been made in baths for brass and nickel plating. Lanseigne and Leblanc have shown that adherent deposits of silver, gold or copper may be made upon aluminum by adding phosphate of soda to the cyanide solutions of the respective metals. Electroplating upon wood has been accomplished by the method of Burgess, in which a conducting surface is obtained by treatment with sulphate of copper and sulphuretted hydrogen, and the electrical reduction of the resulting sulphide of copper.

The reverse process to electroplating, *i. e.*, the electrical removal of metallic coatings, is sometimes desirable. The method of Röder for removing nickel or copper plating from iron consists in the use of a solution of nitrate of soda, the plated iron forming the anode. With the passage of the current the nickel or copper goes into solution while the iron is not attacked, the dissolved metal being also thrown down at the negative pole as hydroxide. The pressure should not exceed 2 volts. The method of Linde is similar, using a solution of carbonate of ammonia, and is available for removing copper, cobalt, nickel, tin, or zinc from iron.

The above outline includes only the salient features of Dr. Krüger's paper, but will serve to give a general idea of the lines along which progress in electrochemistry is being developed, and with the growing appreciation of the capabilities of this branch of technical industry wider applications will surely follow.

Work on the Simplon Tunnel.

OPERATIONS are being steadily conducted upon the Simplon tunnel, and from a report in the *Giornale dei Lavori Pubblici*, some idea of the progress made during the last quarter of 1899 is obtained.

At the beginning of the month of October the total length of main tunnel bored from the two headings was 9,653 feet, while by December 31, this had been increased to 12,700 feet, the auxiliary tunnel being slightly shorter, or 11,400 feet. This shows a progress of 3,047 feet for the three months, or a little more than 1,000 feet per month. Since the total length of the tunnel is to be 64,735 feet, it will only be necessary to maintain this rate to have the undertaking completed within the 5½ years of the original estimate.

Usually the rate of work attained at the beginning cannot be maintained in a work of this kind, but by the ingenious use of the auxiliary tunnel as a means of ventilation and the removal of material, it is expected that difficulties from heat and from the handling of débris will not occur to the same extent as in previous Alpine tunnels.

As the work advances it is evident that experience is aiding in its progress. During the three months under consideration there were removed from the Swiss end of the tunnel 4,916 cubic metres of rock, with an expenditure of 19,947 kilogrammes of dynamite, while from the Italian end the quantity of rock taken out was 25,336 cubic metres, and the consumption of dynamite 5,109 kilogrammes. This gives 4.06 kilogrammes of dynamite per cubic metre of rock at one end, and 4.96 kilogrammes at the other, a consumption decidedly lower than during the previous quarter's work.

The auxiliary tunnel is being carried well along with the main perforation, there being 9 connecting galleries opened in the portion on the Brieg side of the mountain, and 6 on the Iselle side, work now going on in the seventh connection. The effectiveness of the ventilation in keeping down the temperature is shown by the fact that the maximum temperature at the head of the workings on the northern portion is 23.6° C. (74° F.), and on the southern heading 30° C. (86° F.).

Much depression was caused among all engaged upon the tunnel by the death of the engineer, Alfred Brandt, on November 25, of apoplexy. It is a matter of curious coincidence that Louis Favre, the engineer of the St. Gotthard tunnel, also died of apoplexy during the course of the construction of that great work, the plans of both men thus being continued by others, although fully conceived by the originators before the work was commenced. Herr Brandt had gained valuable experience in the early part of his career in connection with the work of Colonel Edward Locher, the constructor of the remarkable railway up Mount Pilatus, as well as the later work of the Stansstadt-Engelberg railway, and much of the effective work thus far accomplished at the Simplon Pass has been due to the special devices designed by Herr Brandt himself, as well as to his carefully conceived plans for the undertaking.

Compression in Steam Cylinders.

The experiments of Professor Dwelshauvers-Dery, of the University of Liége, upon the effect of clearance and compression, made about two years ago, and reviewed in these columns at the time (January and September, 1898), attracted much attention and created much discussion among steam engineers both in Europe and America, mainly because they appeared to contradict the hitherto accepted conclusion that the injurious effects of clearance may be neutralised by a proper amount of compression. The original account of these very accurate and interesting experiments appeared in the *Revue de Mécanique,* in which also appeared some of the criticisms of those who did not agree with the conclusions of Professor Dwelshauvers, and now we have a later communication by the Professor, which is of especial interest.

Among all his critics Professor Dwelshauvers says that the only one who appears to have grasped the true meaning of his experiments was Chief Engineer B. F. Isherwood, U. S. N., himself a most thorough and painstaking investigator in the same field, and in a communication to Professor Dwelshauvers, published in the *Revue de Mécanique* in April, 1899, Mr. Isherwood gave his views upon the Liége experiments to the public. We now have a final paper from Professor Dwelshauvers, also in the *Revue de Mécanique,* relating the results of some later experiments made by him for the purpose of testing Mr. Isherwood's views, and it is refreshing to see how completely the Professor is willing to acknowledge his acceptance of the modification in his original theory which Mr. Isherwood's criticism developed.

It will be remembered that Professor Dwelshauvers maintained that his experiments proved that increased compression showed a positive loss, increasing rapidly as the degree of compression was increased, and he explained this action by stating that the compressed exhaust steam was subjected to cylinder condensation in a manner similar to that known to occur with live steam when first admitted to the cylinder.

Mr. Isherwood, after a careful examination, declared the experiments of Professor Dwelshauvers to be very accurate, and accepted fully the reliability of his results, but gave them a different interpretation. His theory was that the loss revealed by the experiments was due, not to cylinder condensation so much as to the increase in negative work due to the compression, while the positive, or absolute work, to use the expression of Hirn, remained with little or no change; the steam consumption being almost exactly proportional to the absolute work. If this theory be correct, such experiments, made with the absolute work varying according to the degree of compression, in such a manner that the indicated work remains constant, should show the same consumption of steam, whatever the degree of compression.

It was to verify the theory thus enunciated by Mr. Isherwood, that Professor Dwelshauvers repeated the experiments under the conditions suggested in that theory, and in the early part of 1899 three series of trials were made, one without compression, one with 4-10 compression, and with 6-10 compression, each series consisting of 10 trials except the last, which was interrupted after three trials had been made, owing to an accident with the apparatus.

In these experiments every effort was made to have the conditions identical throughout, so far as speed, brake-load, boiler-pressure, and indicated power were concerned, and the slight variations which occurred in these respects were carefully observed and recorded. Professor Dwelshauvers gives the data of the tests in his paper, very fully tabulated, and the comparative results of all the details may there be found. It is sufficient to observe here that Mr. Isherwood's theory was fully borne out by the trials, the consumption of steam per indicated horse power per hour remaining the same whatever the degree of compression when the indicated work remained constant.

Thus, during the three sets of trials the average of the results were as follows:

Steam consumption per i.h.p. hour:

Without compression	11.116 kilogrammes
With 4-10 compression	11.127 kilogrammes
With 6-10 compression	11.273 kilogrammes

These are practically identical, the variation being altogether within the errors of observation, and the individual results of the separate tests show a corresponding uniformity.

Again, taking the ratio of the indicated work to the total quantity of heat expended, we have for the thermal efficiency in the three series:

Without compression	8.42 per cent.
With 4-10 compression	8.44 per cent.
With 6-10 compression	8.37 per cent.

The greatest difference here varies less than 1 per cent. from the mean, and the theory of Mr. Isherwood is completely confirmed.

These additional experiments, taken in connection with those previously made public by Professor Dwelshauvers, constitute a most important contribution to the subject of the action of steam in the cylinder, and his very fully tabulated data and results of the tests, together with this final discussion upon the theory of Mr. Isherwood, form a very satisfactory record of a most important investigation.

The Budapest Acetylene Exposition.

LIGHTING by acetylene has now reached a stage where it commands expositions of its own, much as was the case with electricity in the earlier phases of its application to lighting, and the second of these expositions was held in the latter part of last year at Budapest. A general review of the exhibits there shown forms the subject of a paper by Herr Karl Neudeck, in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, the author being the delegate of the society to the exhibition, and this report forms an excellent view of the present status of the subject at the present time.

The use of acetylene gas involves three distinct elements; the carbide, the generator, and the burners. Although the manufacture of carbide is impracticable as an exhibit, owing to the fact that commercial reasons demand the employment of large installations, driven by water-power, yet the material itself is an important subject for discussion, especially as regards its purity, most of the impurities which require additions to the generator for their removal from the gas, having their origin in imperfections in the method or material in manufacture. The presence of phosphorus or sulphur in the raw materials causes the formation of phosphuretted or sulphuretted hydrogen in the generator, while ammonia and other objectionable compounds are produced if impure carbide is employed. Purifiers are therefore generally necessary, but these may be considered as forming a portion of the generating apparatus.

Generators may be divided into two classes, the object of both being to effect a controlled combination of carbide and water. In one class a small quantity of water is fed to a large quantity of carbide, and in the other a small quantity of carbide is added to a large quantity of water. The first method permits generators of simple design, but it has a number of operative drawbacks, such as the generation of much heat, the clogging of taps and pipes, the inability to check generation of gas promptly, or to effect complete decomposition of the carbide, yet a number of practical generators upon this system have been made and were exhibited at Budapest, but most of these were for small installations.

The second class, in which the carbide is fed into a comparatively large quantity of water, avoids any objectionable elevation of temperature, the gas being cooled by bubbling up through the water, and most of the ammonia and sulphuretted hydrogen being absorbed. The complete immersion also insures the total decomposition of the carbide, and the only practical difficulty experienced in this class is that of regulating automatically the feeding of the carbide.

Both classes of generators were represented at the exposition, as well as a variety of burners, and also a few motors intended to be operated by acetylene instead of ordinary coal gas.

These various exhibits are illustrated and described in detail in Herr Neudeck's report, which is too voluminous to be reviewed except in a general way. As already stated, the dropping of water upon the carbide, the earliest system employed, was used in but few of the smaller generators exhibited, but the modifications of it in which the water rising or falling comes into or out of contact with carbide in a cage or open holder, appeared in several instances, the mechanical simplicity of regulation possible by this method evidently appealing to the designers.

Of more interest are the generators based upon the principle of feeding the carbide directly into a comparatively large body of water, decomposing it immediately and completely into the full quantity of gas possible; and the machines of this type exhibited were numerous, and many of them ingenious. For small plants the carbide may be fed in by hand, a few lumps sufficing to deliver into a suitable holder enough acetylene to supply several burners for an evening; but for regular service, such as in hotels, warehouses, and simlar situations some automatic feed is desirable. This automatic feed is generally accomplished by the rise and fall of the gas holder, some form of ratchet mechanism acting to drop a charge of carbide into the generator when the bell of the holder has reached its lowest position. Attempts to feed the carbide in through a funnel and feed-wheel have not been generally successful, there being a tendency to clog unless the carbide is crushed, and in the later machines the plan of having the carbide placed in a number of compartments, successively opened as the demands for it require, seems to be the favorite, most of the machines exhibited being of this type.

In the important department of burners there does not seem to have been much progress made, most of the exhibits being of the form employing two jets, impinging upon each other to form a flat flame at sufficient distance from the aperture to prevent the clogging due to overheating, so objectionable in the early forms of burners. The tips of the burners are still generally made of steatite, and in some cases shields are used to protect the capillary openings from the obstructing deposit which forms from the polymerization of the acetylene by heat. Burners of the Bunsen type, in which air is mingled with the acetylene just before combustion, seem to have dropped out altogether, as none was exhibited, and the important field of mixed acetylene and oil gas, so successfully used in Germany for car lighting, was not shown, although this is the one application of acetylene which appears to have been established upon a commercial basis.

Reference has been made to the purification of acetylene, and among the methods employed at the exposition may be mentioned that of Wolff, using chloride of lime, and those of Frank and of Ullman; the former using an acid solution of copper salts, and the latter chromic acid.

Judging from the results of the use of acetylene in motors at the exposition, it is still too expensive to be employed as a source of motive power. The engine tested used 500 to 700 litres of illuminating gas per horse-power-hour, and 180 to 220 litres of acetylene, but the higher cost of the latter brought the cost of a h. p. hour up to 3.5 to 4.9 kreutzers for gas, and 15 to 18 kreutzers for acetylene, although the latter might occasionally find employment when a greater power was desired in a given space and weight, regardless of cost.

The Technical Applications of Liquid Air.

Ever since the development of practical processes for the commercial production of liquefied air the question has been asked: "Of what practical use is it?" Various answers have been given, some preposterous, others unwarranted, and still others more moderate and reasonable. To this latter class belong the paper by Dr. Carl Linde, presented before the German Society of Naturalists and Physicians, and published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*.

Dr. Linde points out that liquid air possesses three properties which may be considered in connection with its possible technical applications: its low temperature, its adaptability for the conversion of calorific energy into mechanical work, and the possibility of using it to separate the constituents, nitrogen and oxygen, by fractional distillation.

The applications of liquid air as a refrigerant are shown by Dr. Linde to be very limited. He demonstrates that a given amount of cooling will cost theoretically 17 times as much when performed with liquid air, as when an ordinary refrigerating machine is used, and that owing to the much lower efficiency of the liquefying apparatus, the actual cost is about 40 times greater for the former than for the latter apparatus. Liquid air is therefore only applicable when much lower temperatures than those possible with refrigerating machines are demanded, or in the limited number of cases. such as in medicine and surgery, in which cost is of secondary consideration.

A similar state of affairs exists with regard to the use of liquid air as a source of motive power. It is true that liquid air can be used to operate motors, but even if it were to be had without cost the efficiency is very much lower than is the case with motors operated with liquid hydrogen oxide (*i. e.*, water). We have also seen that the cost of liquefying the air is also high, so its use for motive power is probably to be limited to such special applications as torpedoes, submarine boats, and other similar work. An indirect use of liquid air, however, is that in connection with petroleum in internal combustion motors. In this case the charge of liquid air is mixed with the proper proportion of petroleum, and the power developed by the complete combustion utilized in a cylinder. A powerful motor of small weight may thus be constructed, possibly well adapted for motor vehicles. The application of liquid air as an explosive is also mentioned, although experience with it on the Simplon tunnel work has not been favorable.

The fractional evaporation of liquid air, possible because of the difference in the boiling points of liquid oxygen and nitrogen, may prove of commercial value for the production of air containing a large excess of oxygen. When liquid air is permitted to evaporate slowly at atmospheric pressure the vapour which comes off at first consists of 92 per cent. nitrogen and 8 per cent. oxygen, the last remaining portion being rich in oxygen. By using the cold produced by the evaporation of the first portion to assist in the liquefaction of a new portion of air there need be little or no waste, and as a result it is possible to produce air containing 50 per cent. of oxygen for 2.5 pfennigs per cubic metre.

REVIEW OF THE AMERICAN PRESS

Electric Traction Under Steam Conditions.

NOTWITHSTANDING the success which has attended the application of electric traction to street and suburban service there appears to be a marked hesitancy of the main line railways to consider its use in general work. The most extensive installations which have been made of electric traction upon roads formerly operated entirely by steam have been those of certain branches of the New York, New Haven and Hartford Railroad system, about the city of Hartford, in Connecticut. The paper of Mr. Edward C. Boynton, who is actively connected with the management of these electric railways, therefore attracted much interested attention when presented recently before the American Institute of Electrical Engineers, and a full review of it is here given.

In considering electric traction under steam railway conditions Mr. Boynton divides the local passenger traffic to which it is applicable into two classes. One of these is suburban traffic, now largely carried on by trolley cars, and the other is that existing between cities and towns in close proximity. The first kind of service can only be improved by the use of higher speeds, and unless this gain can be made there is little advantage in introducing the electrically-operated railway. In densely populated districts, however, where there are numerous towns within moderate distances, the present steam communications, effected by means of heavy trains at intervals of several hours, may advantageously be replaced by an electric train service, consisting of two or three-car trains, running every half-hour from each end, with a maximum speed of fifty to sixty miles per hour, and a fare of one cent per mile. Such conditions exist on steam railroads in many parts of the United States. It is on such branch lines, or such short direct lines between cities large enough to provide a constant travel in both directions, that electric traction may be successfully introduced, and it is this kind of service that the roads upon which Mr. Boynton gained his experience are furnishing.

It does not appear probable that electricity will supersede the steam locomotive for hauling freight, at least not until conditions have very materially changed. The economy of the modern freight locomotive and its satisfactory operation in practical service render this branch of railroading one which is least likely to be replaced by any change in motive power. The same is true of through express trains on trunk lines, so that the introduction of electricity on main line work must be expected to come by way of the branch lines, as above indicated, at least at first.

Mr. Boynton gives some interesting data about equipment and operation, especially in connection with the all-important question of costs. During the experimental period reliable data were lacking, and very indefinite answers only could be given to most necessary questions. Several methods may be adopted in the equipment of a road for operation by electricity. These methods are:

First: The purchase of electric locomotives of sufficient power and weight to haul its standard passenger coaches.

Second: The equipment of a number of its standard coaches as motor cars.

Third: The purchase or building of a sufficient number of special light passenger coaches, some of which are equipped as motor cars, and the withdrawal of its standard coaches entirely from this service.

Fourth: Shall freight be hauled by electricity or steam?

The use of electric locomotives is recommended only when the travel is heavy enough to require trains of four or more cars and the runs are long. It has the advantages of providing a form of motive power similar to the steam locomotive, rendering little or no change necessary in the making up or dispatching of trains, and hence is apt to be regarded with favor by railway managers.

The second method, that of equipping

standard coaches as motor cars, must be regarded as the cheapest and most convenient way to make the change from steam to electricity. Mr. Boynton goes at length into the details of equipping coaches in this manner, describing the construction of the motor truck suitable for the conversion, together with methods of wiring and other features.

The third method is very similar to the second, except that the use of light trailers, especially built for the service, enables the dead weight to be reduced, thus reducing the weight of permanent way, and diminishing other details.

The question of hauling freight by electricity Mr. Boynton considers as aside from his discussion of the subject, regarding it as a matter which concerns the future more than the present.

In addition to the cost of equipping the motor cars, the construction and equipment of the power house must be considered. Without going into the details of the engineering construction, and emphasizing only the necessity for selecting a location where water is plentiful and fuel cheap, he states that experience has shown the cost of a power station to be from $80 to $90 per kilowatt, exclusive of the cost of the land.

The cost of operation necessarily varies in different localities, especially for the steam locomotive, so that comparisons cannot readily be made. Mr. Boynton assumes, however, a fair average cost of running a steam locomotive, with coal at $2.30 per ton, and including water, wages, repairs, etc., to be 22 cents per mile, or including wages of train crew, 30 cents per mile. For the electric traction the corresponding costs, based upon his own extensive experience, foot up but 14 cents per train-mile.

The Testing of Steam Engines.

A REVIEW of a portion of a forthcoming work by Mr. George H. Barrus, on the testing of steam engines, is given in a recent issue of the *Engineering Record,* and in view of Mr. Barrus' extended experience in this special branch of engineering some of the points will bear repetition and emphasis.

Mr. Barrus gives some valuable suggestions with regard to the measurement of feed water, and although this relates more to boiler than engine testing, yet it is important in both cases, and sometimes in engine testing large quantities of water other than feed must be measured. Naturally the best method of determining a quantity of water is the indirect one of weighing it, but this is not always practicable. Meters, when used, should be carefully calibrated, this being best done by running a large volume of water through the meter, the water being delivered alternately into two barrels, the count of barrels being kept and the weight of water in a barrel determined. A rating can thus be obtained by which the meter readings can be corrected.

The orifice method of measuring water may be adopted when any change in existing connections is not permissible. If the head of water on a given orifice is maintained constant, and the flow accurately timed, the rate of flow can be determined afterwards, and the amount of water computed. The importance of testing for leaks is emphasized, and a leakage trial should be made immediately after a test, care being taken to have boiler pressures and all conditions which might affect leakage kept as nearly the same as possible as they were during the trial.

Mr. Barrus naturally gives careful attention to the use of the indicator, and, assuming that the reader is familiar with the general use of the instrument, he goes on to give many useful hints derived from long experience with it in engine testing. The best methods of giving correct motion to the paper drum for engines of different kinds, the arrangement of cords for simultanous use of several instruments on multiple-cylinder engines, and the avoidance of error by the use of the best methods of piping, all these are discussed, and the use of the judgment encouraged in selecting the method of connection best adapted to the case under test.

For those who admire a single line, clean-cut diagram, the method of Mr. Barrus for getting at the true performance may be interesting, he evidently preferring to obtain a knowledge of the actual work of the steam rather than to get a show card.

"In taking diagrams from an engine

with the object of determining its power, it is not desirable to limit the diagram to a single revolution. The marking point of the indicator should be applied long enough to obtain four or five diagrams, corresponding to that number of successive revolutions, in order that the effect which the fluctuations in the governing mechanism has upon the diagrams may be provided for.

"When a load is extremely fluctuating this system should be carried still further. The period of taking the diagram should extend over at least a full minute, though it is unnecessary to make it a continuous diagram for this length of time. The marking point can be preferably applied for three or four revolutions at the beginning of, say every ten seconds of a minute, and in that way the record applies to some twenty revolutions spread over the full period. Having these diagrams now on the same card, an average line can be dotted in by hand, using the best judgment after examining the appearance of the various diagrams and their location."

This method is especially applicable in testing engines in electric-railway power-plants, and indeed except by some system of this kind it is not practicable to obtain a fair idea of the actual indicated horse-power. By taking diagrams at intervals of not more than ten or fifteen minutes, all engines being indicated simultaneously at a given signal, a general record of the total power may be worked up which will be very near the actual condition of affairs. It is in such details that the judgment and experience of the engineer appears, and it is only by such intelligent use of instruments and methods that tests of permanent value can be made.

Modern Masonry Construction.

The paper of Mr. David Molitor upon the present status of engineering knowledge respecting masonry construction, presented before the Detroit Engineering Society, and published in the *Journal of Associated Engineering Societies,* forms a valuable contribution to one of the oldest branches of engineering work.

After showing that, in spite of the voluminous mass of literature upon the subject, the knowledge of the theory is really very meagre, Mr. Molitor proceeds to take up various branches, briefly indicating the most modern ideas as compared with the time-honored formulas and methods of the text books.

Beginning with the question of earth pressure, the earlier theories are examined, and it is shown that they are based on assumptions which cannot be harmonized with the facts observed in practice. The assumptions that earth possesses a constant angle of repose, that separation takes place by the severing and motion of definite prisms, and that there is a definite point of application of the resultant of earth pressure against a wall, these are all practically erroneous, as are consequently the theories built upon them. The French experiments of Leygue and of Chaudy have shown more clearly the true behavior of earth particles, and while further experiments on a large scale are desired, yet it is possible to analyze graphically the conditions in a manner which enables retaining walls to be constructed in a rational manner. Rupture is shown to take place along a curve, not on a plane; the question of the friction of the particles must be considered, and the point of application of the resultant of the pressure must be determined for each case.

The important subject of masonry arches is examined at length, and the weight which the Austrian experiments have had upon the revision of the older theories is acknowledged. The application of the graphical and analytical methods to fixed arches is shown by practical examples, although it is maintained at the same time that the large factor of uncertainty necessitates a very high factor of safety in such structures. Hinged arches are advocated as decidedly preferable, both as being free from initial stresses otherwise present in fixed arches after releasing false work, and because small abutment displacements and changes in temperature do not affect the magnitude or distribution of stress in the arch ring.

Mr. Molitor gives some attention to reinforced concrete masonry construction, both as applied to retaining walls and to arches, the methods of Melan, Moeller, and Monier being especially discussed, and the combination recommended. The introduction of iron or steel in concrete at once permits tensile stresses to be incurred, a large economy thus being made possible.

"The widely different physical properties of concrete and iron do not seem to offer any serious obstacles, as was at first predicted; at least, none have developed during past experience. Concrete appears to possess an adhesive strength with iron which is equal to or even greater than the tensile strength of the former; the coefficients of expansion are nearly enough equal in the two materials to offer no serious objections, and by a proper distribution of loads their elastic properties may be harmonized as to make them work fairly well together."

Mr. Molitor's paper emphasizes the importance of providing by experiment a greater fund of reliable data upon which to base correct theories, and urges the initiation of full sized tests of retaining walls under various earth pressures on a scale comparable with the Austrian arch experiments, and shows the futility of deducing, or attempting to deduce, the conditions in a great masonry structure by miniature experiments in the laboratory.

Annealing by Electricity.

THE use of hardened steel in various constructions, notably in armor plate and in the construction of burglar-proof vaults, brings into notice the difficulty of drilling or otherwise working the material by machine tools after the hardening process has been performed. An interesting paper upon the method of removing the hardening locally, by means of the process of electric annealing, was recently presented before the Engineers' Club of Philadelphia by Mr. Charles A. Dougherty, and published in the *Proceedings* of the Club.

Harveyized nickel-steel armor plate, or plates prepared by the Krupp process, are altogether too hard to be drilled or worked after hardening, and hence it has been the practice either to drill all holes before hardening, or to protect the surface of the plates in patches or strips to prevent carburation wherever holes were expected to be drilled. It is very often difficult to determine the exact location of the holes required, and even with the utmost care in the preparation of the drawings it is found necessary to proceed with the fitting of the plates on the vessel before the holes can all be precisely placed.

Attempts have been made to anneal spots where holes were to be drilled, but neither the oxy-hydrogen blowpipe nor the electric arc proved satisfactory. Under these circumstances experiments have been made with an electric apparatus similar to that employed for electric welding, with results which appear to be satisfactory and which are described in detail in Mr. Dougherty's paper. The apparatus, as made by the Thomson Electric Welding Company, consists of an alternating current generator giving a voltage of 300, and an amperage of 100. The annealing machine proper is an alternating-current transformer similar to the well-known transformers used in welding steel rails.

"The transformer is of the copper-clad type; that is, one in which the secondary is composed of two copper castings, each having a rectangular groove; when bolted together these form a closed rectangular frame in which the primary coil is held. The hollow space intervening between the primary and secondary is filled with a heavy body oil called "transil" oil. This oil acts both as an insulator and a conductor of heat from primary to secondary. The secondary, by completely surrounding the primary, affords an excellent mechanical protection, and prevents electrical as well as magnetic leakage. The latter features are quite important, since it is necessary to operate the annealer on board vessels in exposed positions during construction, yet it may be handled with immunity from electric shocks, even when operated in rain or in heavy snow. The primary coil of this transformer consists of a copper ribbon, each turn of the coil being insulated from the next by thin asbestos paper. The ratio of conversion is 100 to 1, and when the maximum voltage of 300 is generated at the brushes of the generator, there is about 2.5 to 2.8 volts at the terminals of the secondary of the transformer."

This transformer is connected to two copper terminals, forming contacts by means of which the current is made to enter and leave the plate to be annealed. These contacts are provided with an internal water circulation to keep them cool, and are made of various forms, according to the work to be done.

The passage of the current raises the temperature of the spot to about 1,000° F., with the result of withdrawing the temper very completely. The contact surface on the plate is seldom more than about half an inch square; yet 10,000 amperes are made to flow through it during the process of annealing. This current density per contact area is equivalent to 40,000 amperes per square inch, a density which is only rendered possible by the thorough cooling of the copper contacts by the continuous water-circulation through them.

It was at first supposed that the heating would draw the temper of the hardened steel without any especial method of cooling afterwards, but experience proved that when the current was shut off the heat was carried away so rapidly by the surrounding mass of metal that the heated spot became chilled, just as if it had been plunged into cold water. As a consequence of this action it was found that only a gradual and slow withdrawal of the current would produce the complete effect of annealing.

The practical operation of this apparatus at Cramps' shipyard in Philadelphia, has shown that the temper can be drawn at any desired spot so that a hole can be drilled, while at the same time the resisting power of the rest of the plate remains unchanged. Even with the new Krupp process armor, in which the surface hardening extends to a depth of two inches, the electric annealing is perfectly accomplished.

An American Drafting Room.

Formerly it was thought that any out-of-the-way room would serve for the draftsmen of a machine shop, and some proprietors seemed to grudge every dollar which was expended in making drawings, or working over designs. A marked contrast to this state of affairs is seen in the new drafting rooms of the Brown & Sharpe Manufacturing Company, of which an excellent account is given in a recent issue of the *American Machinist*.

In connection with the offices for the engineers, the drafting room occupies an entire floor 127 feet long by 47 feet wide, besides additional space for photographing and blue printing departments. About one-third of the floor is divided off for private engineering offices, and the balance is equipped with drafting tables, cases for drawings and general drafting appliances. A saw-tooth skylight furnishes ample light, the lighting being controlled by shades and diffused by the color of the walls, while especial attention has been given to the warming and ventilation; the theory being held that the physical comfort of the men is essential to the production of satisfactory results.

It is necessary to examine the photographs of the room to obtain a proper idea of the arrangement, but some features of the system may be referred to here. All drawings are filed in cases in the room where they are readily accessible, and a card index enables any sheet to be found at once, and the old-time experience of wasted time hunting for missing drawings is made an impossibility. Drawings and blue prints sent out into the works are charged to the department receiving them, and all changes in patterns, and shop notes suggesting changes, are recorded on the drawings themselves. Sketches and notes are filed and indexed, and the card index of photograph negatives includes prints of each negative, so that it may be identified by appearance as well as by name.

An 8 foot reversible blackboard is a convenience for use in making full size preliminary sketches to get general proportions, and the drawing tables are of two sizes, 3 by 8 feet and 3 by 16 feet, there being accommodation for fifty draftsmen without crowding.

The whole equipment is a model for imitation wherever a modern drafting room is under consideration, and there can be no doubt that the cheerful and attractive surroundings fully repay their cost in the higher character of service given by the men there occupied.

The Discharge of the Niagara River.

In view of the increasing use which is being made of the Niagara hydraulic power the recent measurements of the flow of water in the Niagara, made under the direction of the U. S. Board of Engineers on Deep Waterways, is of more than usual interest. A very full account of this work is contained in a paper by Mr. Clinton W.

Stewart, recently presented before the Western Society of Engineers, and from the very elaborate account the following is condensed.

The measurements were made at Buffalo, at the head of the Niagara river, or the outlet of Lake Erie, the discharge section being taken on the line of the guard rail on the north side of the International Bridge about 3 miles below the head of the river. By thus using the bridge it was possible to take accurate soundings and readily obtain a correct cross section, two distinct and independent sets of soundings being taken, and the discrepancies gone over and corrected.

The cross section having thus been determined, the velocities at a number of points of the section were taken by the use of current meters of the Haskell form. This is a propeller meter of the so-called "Woltmann Mill" type, the modifications being in the form of the blades and in the introduction of electrical recording and controlling apparatus. A make-and-break device in the body of the meter causes electrical contact to be made and interrupted once for every revolution of the spindle. A stop watch is also included in the circuit and so arranged that the starting of the stop watch completes the circuit, or vice versa. The current meters were all carefully calibrated and the results of many trials plotted on section paper, any variations from the mean to any great extent being rejected, and the rest treated by the method of least squares. The care which was given to the rating of the meters renders the results very trustworthy, and it is probable that the instrumental errors in the final results are both few and unimportant.

The general method of proceeding in taking the discharge measurements was to measure the velocity at some percentage of the depth at stations on the cross section, passing from one to the other as rapidly as possible. These stations were called the meter stations and were about 80 feet apart. In the short spans of the bridge they were situated at the stations 2-8ths and 6-8ths, and in the longer spans at the stations 2-12ths, 6-12ths, and 10-12ths. In this way each observation represented a width of river corresponding to one-half or one-third of the span and was located in the middle of that part. As the general shape of the cross section of each span was somewhat triangular, in order to reduce the observed velocity to mean velocity it was necessary to have a system of vertical curves, showing the variation of the velocity in a vertical plane, and a system of transverse curves showing the variation of velocity as the river is crossed. The combination of the two sets of curves gives a coefficient which, multiplied by the area of the cross section of the corresponding one-half or one-third span gave the discharge.

The details of this portion of the work are given very fully in Mr. Stewart's paper, the coefficients being computed for every foot variation in the height of the water, within the limits of observed variations of level. Gauges were also set to enable the slope of the surface to be measured, and the effect of wind conditions was also carefully observed.

After a careful study of the 72 discharges which were measured, 43 were accepted as being the most reliable, these covering a range of level in the lake of about 2.3 feet. A curve was adjusted to fit these 43 observations by the method of least squares, this enabling discharges for any intermediate level to be taken off.

Taking the mean level of Lake Erie at 572.78 feet, this being the mean of the annual elevations of the lake at Cleveland from 1871 to 1895, the corresponding discharge of the Niagara river was found to be 229,100 cubic feet per second. This level, however, was found to be too high by 0.3 feet, from 10 years' observations of the difference in level between Cleveland and Buffalo, and making this correction the mean flow of the river is given as 221,500 cubic feet.

"Should a certain amount of the discharge of the lake be diverted from the natural outlet, the effect on the lake level can be directly obtained by taking the proportion of the amount diverted to the rate of increase or decrease in discharge per foot of rise of the lake. Should 10,000 cubic feet per second be diverted from the discharge of the Niagara river by the Chicago drainage canal, the effect would be to lower the level of Lake Erie by 0.4 feet."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *qr.* a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Cast Iron.

See Mining and Metallurgy, Iron and Steel.

Chimney.

See Mechanical Engineering, Steam Engineering.

Columns.

The Design of Columns for Sheds Exposed to Wind and of Concrete Bases for Columns. Leopold Mensch. Computations for concrete bases, and calculations of structures like freight and passenger sheds. 900 w. Eng News—Feb. 1, 1900. No. 32354.

Concrete Floors.

Tests of a Reinforced Concrete Floor. Describes investigations made at a Montreal office building. 800 w. Eng Rec—Feb. 3, 1900. No. 32316.

Derrick.

See Electrical Engineering, Power.

Grand Stand.

A Large Steel Grand Stand. Illustrated description of a structure at Yonkers, N. Y., which is 400 ft. long, 62 ft. wide, and seats 7,700 spectators. The structural details of the column and roof connections, and other special features, are explained in detail. 1900 w. Eng Rec—Feb. 10, 1900. No. 32425.

Reconstruction.

Reconstruction of the Manhattan Bank Building. Illustrated description of the repairs and strengthening of an office building seriously damaged by fire. Describes the strengthening of the foundations, re-enforcement of columns, and construction of fireproof floors. 1000 w. Eng Rec—Feb. 3, 1900. No. 32315.

Underpinning.

Street-Front Reconstruction. Illustrated description of the method used in a Toronto building to replace masonry wall piers with steel columns on the same foundations. 500 w. Eng Rec—Feb. 10, 1900. No. 32426.

HEATING AND VENTILATION.

Blowing Fans.

Methods of Testing Blowing Fans. Review of a paper by R. C. Carpenter, explaining the sources of error in such tests and describing the apparatus and methods he has found most satisfactory. 2000 w. Eng Rec—Feb. 3, 1900. No. 32317.

Car Ventilation.

See Railway Affairs, Equipment.

Dust.

Removal of Dust from a Boiler Room. Illustrated review of a paper by A. A. Cary on a plant designed to intercept all the dust given off in the boiler house of a wire-insulating plant. 900 w. Eng Rec—Feb. 3, 1900. No. 32318.

Hospital Ventilation.

Neglect of Ventilation in Some Hospitals. Thomas Barwick. Read before the Am. Soc. of Heat. and Ven. Engs. Describes the conditions found in various hospitals, showing the lack of proper ventilation. 1500 w. Dom Engng—Feb., 1900. No. 32560 C.

Hot Air.

A Hot-Air Furnace Heating System. Illustrated description of a plant in a 66 x 43 ft. frame house, where provision is made for positive ventilation by special flues and dampers. 1000 w. Eng Rec—Feb. 10, 1900. No. 32427.

Pneumatics.

The Weight of Air. Information on the properties of air, and tables based on the laws of Boyle and Gay Lussac, which will prove useful in engineering calculations. 3300 w. Locomotive—Jan., 1900. No. 32541.

Shop Ventilation.

Heating and Ventilating Plant in the McCormick Harvesting Machine Company's Foundry. J. I. Lyle. Illustrated description of the fan system installed in a Chicago foundry. 1700 w. Foundry—Feb., 1900. No. 32496.

Station.

Ventilation and Heating of the Nashville Union Station. Illustrated description of an unusual plant in a 145 x 149 ft. building, 5 stories high. 3000 w. Eng Rec—Feb. 24, 1900. No. 32721.

MISCELLANY.

Color.

Color in Architecture. John Gemmell. Presented at convention of Ontario Assn. of Architects, Toronto. Considers the use of materials and the lessons to be learned from nature. 2800 w. Can Archt—Feb., 1900. No. 32715 C.

Fireproofing.

See Civil Engineering, Materials.

Lecture.

Progress in Architecture. Prof. Aitchison. First lecture on this subject to the students of the Royal Academy. 4000 w. Builder—Feb. 10, 1900. No. 32568 A.

CIVIL ENGINEERING

BRIDGES.

Cantilever.

Cantilever Bridge Over the Chéliff, Algeria (Pont à Jonction Centrale Partielle sur le Cheliff, Algérie). A. Dumas. With views showing the method of erection without false works, and data concerning the construction. The central span is 148 feet. 1800 w. Génie Civil—Feb. 3, 1900. No. 32603 D.

The Kaisersteg Bridge. H. Müller-Breslau, in *Zeitschrift für Bauwesen.* Illustrated description of a 573-ft. cantilever bridge with center hinge and a stiffening arch, in which the curves of the chords were determined by a unique method, described in detail. 800 w. Eng Rec—Feb. 17, 1900. No. 32523.

Continuous Girder.

Graphical Determination of the Pier Reactions of Continuous Girders of Constant Moment of Inertia (Zeichnerische Bestimmung der Stutzmomente Continuirliche Träger von Constantem Trägheitsmomente). L. Geusen. With numerous diagrams, adapted for a variety of cases occurring in practice. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 2, 1900. No. 32626 B.

Counterbracing.

Framed Girders with Diagonal Counterbracing (Fachwerkträger mit Gegendiagonalen). Karl Haberkalt. A discussion of the action of counterbraces in bridge trusses, maintaining that the desired stiffness can better be obtained by strengthening the main members. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1900. No. 32653 D.

Railway Bridges.

Economies in Railway Bridge Design and Manufacture. J. Graham. Considers the subject in relation to bridges for export, in order that England may meet outside competition. 2200 w. Engr, Lond—Jan. 26, 1900. No. 32371 A.

The Lehigh Valley Railroad Bridge at Easton, Pa. Illustrated description of a structure consisting of 8 trusses and a 630-ft. viaduct approach. The truss spans are very much skewed at both ends, and the difficulties of alignment and centrifugal strains due to rapidly moving heavy trains, developed special features of construction which are explained in detail. 2600 w. Eng Rec—Feb. 10, 1900. No. 32418.

Rhine.

Arched Bridges Over the Rhine. Illustrated accounts of two remarkable bridges. Part first describes the Bonn bridge. 1500 w. Engng—Feb. 9, 1900. Serial. 1st part. No. 32585 A.

Skew.

The Designing of Skew Connection Details for Roof and Bridge Work. C. A. P. Turner. An illustrated discussion of methods used in determining dimensions. 4000 w. Eng News—Feb. 15, 1900. No. 32516.

South Africa.

The Frere and Tugela Bridges. Engravings giving an excellent idea of the wreckage of these bridges by the Boers, and information concerning the new bridges to replace them. 1000 w. Engng—Jan. 26, 1900. No. 32381 A.

Suspension.

Some Light Highway Suspension Bridges. Illustrated description of two structures of a type now used considerably in sparsely peopled regions. 1100 w. Eng Rec—Feb. 3, 1900. No. 32308.

Swing Bridge.

Construction of 175 ft. Counter Balanced Plate Girder Swing Bridge. W. A. Rogers. Illustrated description of the construction. 3800 w. Jour W Soc of Engs—Dec., 1899. No. 32306 D.

Design of a 175-ft. Counter Balanced Plate Girder Swing Bridge. Albert Reichmann. Illustrates and describes the novel features of probably the largest plate girder counter-balanced swing bridge ever built—on the C., M. & St. P. Ry. at Chicago. Operated by a 25-h.p. electric crane motor. 2000 w. Jour W Soc of Engs—Dec., 1899. No. 32305 D.

Operating Mechanism, Duluth and Superior Swing Bridge. Illustrated description of the electrical apparatus used in moving and locking a 2,000-ton swing span. 2200 w. Eng Rec—Feb. 24, 1900. No. 32722.

Swing-Bridges Over the River Weaver at Northwich. John Arthur Saner. Read at meeting of Inst. of Civ. Engs., London. Brief description of the two bridges and the motive power used. 1100 w. Builder—Feb. 3, 1900. No. 32463 A.

Test.

Destruction Test of the Erlenbach Bridge on the Black Forest Railway (Belastungsprobe bis zum Bruch der Erlenbachbrücke der Schwarzwaldbahn). F. Schüle. This lattice girder bridge had been in use for 30 years, and being superseded, was made the subject of an experimental test. 1200 w. Schweizerische Bauzeitung—Jan. 13, 1900. No. 32637 B.

Viaduct.

New Viaduct Construction on the C. & E. I. Ry. Illustrated detailed description of two steel viaducts, one over Little Saline Creek, and the other over Grasshopper Creek. 1200 w. Ry & Engng Rev—Feb. 17, 1900. No. 32557.

CONSTRUCTION.

Columns.

See Architectural Engineering, Design.

Embankments.

Building Large Embankments on the Boone County Ry. (C. & N. W. Ry. System). Information concerning the work, with illustration. 700 w. Eng News—Feb. 8, 1900. No. 32410.

Excavating.

A New Type of Excavating Machine. S. H. Lea. Illustrates a novel machine not yet placed on the market. It is known as the "Big Auger" and has not been successfully operated. 500 w. Eng News—Feb. 8, 1900. No. 32406.

Pile Drivers.

A Portable and Collapsible Pile Driver. Illustrated description of a driver with 40-ft. leads capable of working vertical or inclined piles on the sides or ends of its cars, which can be folded up into a very small space for transportation. 700 w. Eng Rec—Feb. 17, 1900. No. 32529.

Pneumatics.

Pneumatic Work. D. E. Moran. Address before the Central States Water-Works Assn. On the development of pneumatic foundation work. 2500 w. Compressed Air—Feb., 1900. No. 32393.

Retaining Wall.

Retaining Wall of Concrete with Metal Skeleton From *Le Génie Civil.* Illustrates and describes the construction of a temporary street below the general surface, in connection with the Paris Exposition. An application of the Henmebique system of combined concrete and steel was used. 700 w. Eng News—Feb. 15, 1900. No. 32517.

Subways.

Construction of the Ontario and Berri Street Subways, Brock Street Tunnel, and Notre Dame Street Viaduct. Stuart Howard. General description of the works named, with ten plates of drawings. 4800 w. Can Soc of Civ Engs (Adv. Proof)—Feb. 15, 1900. No. 32563 D.

Tunneling.

Municipal Tunnel Driving by Day Labor, Chicago. Paul G. Brown. Illustrated description of the methods employed by the city in completing, at much less than the contract price, tunnel operations which had been abandoned by the contractors. 1800 w. Eng Rec—Feb. 3, 1900. No. 32307.

The Work on the Simplon Tunnel (I Lavori pel Traforo del Sempione). A review of the progress made during the last three months of 1899, with details of the operation of the rock drills and other machinery. 1500 w. Gior d Lav Pubb e d Str Ferr—Feb. 7, 1900. No. 32678 B.

HYDRAULIC AND MARINE.

Bucket Pumps.

A Novel Type of Bucket Pump for Mines, Wells, Boreholes, etc. Illustrated description of an invention of Herbert Ashley, and a statement of its advantages. 1600 w. Ir & Coal Trds Rev—Feb. 2, 1900. No. 32473 A.

Canals.

New York's Canal Policy. What Shall It Be? Editorial discussion, presenting facts that may have influence, and discussing the claims made. 3000 w. Eng News—Feb. 8, 1900. No. 32409.

The Chicago Drainage Canal. Illustrates the great beartrap dam, and explains the benefit the channel will be to towns on its banks, where it will furnish power for various purposes. 1000 w. Fire & Water—Feb. 17, 1900. No. 32561.

The Erie Canal Problem. Editorial outlining the plans presented for consideration. 1400 w. Sci Am—Feb. 3, 1900. No. 32264.

The Great Lakes and New York Waterway. E. P. North. Discussion of the importance of canals in directing railway traffic. 2000 w. Eng Rec—Feb. 17, 1900. No. 32533.

The New Inland Waterway. J. A. Stewart. A technical description of the Chicago drainage canal, with a brief review of the considerations which led to its construction, and many illustrations. 3000 w. Sci Am—Feb. 17, 1900. No. 32504.

The New York Canals. A full abstract of a report of an investigation conducted with hitherto unequalled resources and advantages, by a special commission appointed by the Governor of New York. Also editorial on the importance of the investigation. 6200 w. Eng Rec—Feb. 3, 1900. No. 32311.

The Proposed Neutralization of the Isthmian Canal. Editorial discussion favoring the neutralization by international agreement, and giving reasons for the opinions expressed. 2500 w. Eng News—Feb. 22, 1900. No. 32708.

The Rhine-Elbe Canal and German Industries. On the proposed canal construction, which will furnish a fine system of inland waterways and greatly benefit the coal and iron industries. Map. 7100 w. Ir & Coal Trds Rev—Feb. 9, 1900. No. 32569 A.

What Shall New York Do With Its Canals? The report of the Governor's advisory committee in full. 16000 w. Eng News—Feb. 1, 1900. No. 32355.

Dams.

A Large Crib Dam, Butte, Mont. Describes a structure 319 ft. long, 42 ft. high, and built of round fir logs in cribs 8 ft. square. 1800 w. Eng Rec—Feb. 3, 1900. No. 32309.

The Silting-Up of Lake McDonald and the Leak at the Austin Dam. Thomas U. Taylor. Information relating to the amount of silt deposited, with explanation of theory, an illustrated description of leaks occurring and means of remedying them. 1600 w. Eng News—Feb. 22, 1900. No. 32711.

Docks.

Concrete Dock Construction at the South Works of the Illinois Steel Company. Victor Windett. Illustrated description of the repairs, rebuilding, etc., with account of cost and satisfactory results. 6300 w. Jour W Soc of Engs—Dec., 1899. No. 32303 D.

U. S. Floating Dry Dock at Algiers, La. Drawings and description showing the general construction of this large dock and the approaches, and discussing interesting features. 2500 w. Marine Engng—Feb., 1900. No. 32386 C.

Regulating Dam in the San Juan River (Digue Nivelador, Rio San Juan). José S. Corte. A general description of the dam and of its partial destruction in Dec., 1898, with numerous photographs. 2500 w. 3 plates. La Ingeneria—Dec. 31, 1899. No. 32679 H.

See Mining and Metallurgy, Mining.

Dredge.

American Dredge in Russia. An interesting account of the trials of the Beta, which far exceeded the contract demands. 1200 w. U. S. Cons Repts. No. 647—Feb. 6, 1900. No. 32382 D.

The Kretz Suction Dredge (Kretz'sche Spülbagger). An illustrated description of this improved dredge, in which powerful jets of water are used to disintegrate the material and enable the suction currents to remove it. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1900. No. 32651 D.

Floods.

Flood Damage to the Hudson River Passenger Bridge and Station of the Delaware & Hudson Ry., at Albany, N. Y. An illustrated account of the damage to property. 1100 w. Eng News—Feb. 22, 1900. No. 32709.

Harbours.

Maritime Installation of the Port of Ostend (Installations Maritimes du Port d'Ostende). O. Watrin. A general description of the improved harbour works, with plates showing the construction of the docks and quay walls. 4000 w. 3 plates. Rev Univ des Mines—Jan., 1900. No. 32632 G.

Merchant Shipping in the Harbour of Vladivostock (Die Handelsschiffahrt im Hafen von Wladiwostok). F. Theiss. With map and photographs of the terminal of the Siberian railway, and an account of the business now handled at the port. 1800 w. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1900. No. 32653 D.

Northern Harbors Kept Open. Robert Runneberg. On the American system of building ice-breaking boats, and their use in keeping harbors open. 800 w. Am Mfr & Ir Wld—Feb. 22, 1900. No. 32714.

The New Harbour Work at Bruges (Nouveaux Ports de Bruges). J. Nyssens-Hart. An account of the conduct of the improvement works, with especial reference to the machinery and methods employed in connection with the heavy masonry construction. 3000 w. 1 plate. Rev Univ des Mines—Jan., 1900. No. 32633 G.

The Port of Dunkirk (Le Port de Dunkerque). A description of the new channel and docks, and the effect of improved facilities upon traffic. 3000 w. 1 plate. Rev Univ des Mines—Jan., 1900. No. 32634 G.

Lake Nicaragua.

An Assumed Inconstancy in the Level of Lake Nicaragua; a Question of Permanency of the Nicaragua Canal. Angelo Heilprin. A discussion of the important bearing on the proposed canal, giving instances of marked oscillation in other lakes. 2500 w. Sci Am—Feb. 24, 1900. No. 32701.

Lock Gates.

The Electrical Operation of the New Sea Lock Gates at Ymuiden (Elektrische Bewegungseinrichtungen der Neuen Seeschleuse zu Ymuiden). A description of the electrical plant, and an account of the manner in which the heavy gates of this new lock in Holland are successfully operated. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 19, 1900. No. 32623 B.

Locks.

The Proposed Pneumatic Balance Locks for the Erie Canal. Illustrated description, explaining the principles upon which the locks are operated. 1700 w. Sci Am—Feb. 3, 1900. No. 32267.

Niagara.

Discharge Measurement of the Niagara River at Buffalo, N. Y. Clinton B. Stewart. Describes the apparatus and methods used, the computations, etc. Ill. 10500 w. Jour W Soc of Engs—Dec., 1899. No. 32304 D.

Pipe Line.

The Coolgardie Pipe Line. A description of a steel force main 328 inches long, now under construction to supply the gold fields of West Australia. The pipe is 30 inches in diameter and provided with special forms of longitudinal and round joints. 3500 w. Eng Rec—Feb. 24, 1900. No. 32720.

Reservoirs.

Constructing the Jerome Park Reservoir. Illustrated description of the methods employed in constructing a 2,000,000,000 gal. reservoir for the New York water-works; the excavation is mainly by steam shovels, with blasting, and the concrete plant is out of the ordinary. 2500 w. Eng Rec—Feb. 17, 1900. No. 32524.

Reservoirs in the Vosges (Die Stauweiher in den Vogesen). Thomas Hofer. Describing several important reservoirs in the Vosges mountains in Alsace-Lorraine, with sections of the dams, and plans of the water areas. 3000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1900. No. 32649 D.

The Relation of Reservoirs to Parks. Frederick Law Olmsted, Jr. An illustrated article giving many suggestions for the treatment of distributing reservoirs, so that they may add to the beauty of their surroundings, as well as serve for holding water. 5500 w. Munic Engng—Feb., 1900. No. 32384 C.

Various Reservoirs in Lorraine, Belgium and France (Verschiedene Stauweiheranlagen in Lothringen Belgien und Frankreich). Thomas Hofer. A general description of reservoirs and canals inspected by the author, with plates showing dam and channel construction. 4000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1900. No. 32652 D.

River Improvements.

Proposed Improvements of the Southwest Pass at the Mouth of the Mississippi. Brief sketch of the proposed work, with map. 2100 w. Eng News—Feb. 15, 1900. No. 32519.

Water Meters.

Water Meters of the Present Day: With Special Reference to the Small Flows and Waste in Dribbles. William Schönheyder. Read before the Inst. of Mech. Engs. Divides the meters in use into six classes, treating of each and noting the purpose and advantages of each type. Ill. 5000 w. Engr, Lond—Feb. 2, 1900. No. 32469 A.

Water Purification.

Ozone as a Water Purifier. A review of the experiments of Th. Weyl with apparatus on a commercial scale, together with comments of German engineers on the utility of ozone in water purification. 2200 w. Eng Rec—Feb. 3, 1900. No. 32313.

The Relative Values of Ozone and Slow Sand Filtration as a Means of Purifying Water. Abstract translations from the German, by Allen Hazen. Discussion of Dr. Weyl's paper. 7500 w. Eng News—Feb. 8, 1900. No. 32408.

Water Supply.

Local Government and Its Relation to Parish Water Supply and Sewerage. W. O. E. Meade-King. Discusses small communities in England, aiming to show that wealth as well as health is increased by proper sanitation. Also discussion. 6900 w. Jour Soc of Arts—Jan. 26, 1900. No. 32356 A.

London Water-Supply. Editorial, outlining the prominent features of the report of the Royal Commissioners, and giving comments on the conclusions reached. 2000 w. Engr, Lond—Jan. 26, 1900. No. 32375 A.

The London Water Commission Report. Brief statement of the points dealt with in the final report, with editorial discussion of the conclusions. 6000 w. Builder—Feb. 3, 1900. No. 32460 A.

Water-Waste.

A British View of Water-Waste. Extracts from the report of the Llandaff Commission on the London water-works, in which a supply of 42 U. S. gals. per capita daily is held to indicate waste. 2500 w. Eng Rec—Feb. 17, 1900. No. 32525.

Water-Works.

Florence, Col., Water-Works. R. P. Garrett. Illustrated description of a plant noteworthy for having a submerged dam to force ground water to the surface, and a gravity main about 7 miles long, of vitrified clay pipe. 1500 w. Eng Rec—Feb. 10, 1900. No. 32419.

Outlet Valves, Burrator Reservoir, Plymouth, England. Illustrated description of 3-beat cage valves at the outlets of pipes 25 to 36 ins. in diameter, by the use of which a gate chamber was made unnecessary. 600 w. Eng Rec—Feb. 10, 1900. No. 32422.

The Latest Report on the London Water Companies. A review of the report of the Llandaff Commission, which recommends the purchase of the existing private plants. Gives figures of the nominal and market value of the private plants and estimates of the cost of constructing additional works for a total supply of 504,000,000 gals. 2000 w. Eng Rec—Feb. 10, 1900. No. 32415.

The Relative Responsibilities of Engineer and Contractor. Review of a decision of the Pennsylvania Supreme Court that a contractor, who builds a reservoir in accordance with plans, specifications and engineering directions, cannot be held liable for the failure of the reservoir to hold water. 700 w. Eng Rec—Feb. 17, 1900. No. 32521.

The Water Works of the City of Prenzlau (Das Wasserwerk der Stadt Prenzlau). H. Scheven. The supply is obtained partly from springs and partly by the use of filtered water from Lake Uecker. Details of the filtering and aerating plant are given. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 13, 1900. No. 32611 D.

The Water Works of the X. District, Vienna (Wasserwerk der Stadt Wien in X. Bezirk). Fr. Borkowitz. An illustrated description of this new secondary pumping station, with full details of the compound pumping engines and water tower, and data and results of tests. 3000 w. 4 plates. Zeitschr d Oesterr Ing u Arch Ver—Jan. 26, 1900. No. 32625 B.

MATERIALS.

Buckling.

The Correct Formula for Buckling (Die Richtige Knickungsformel). J. Kübler. An analytical and graphical comparison of the formulas of Euler, Rankine, and Tetmaier, and the derivation of a new formula claimed to represent the relation of the forces correctly. Serial, Part I. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1900. No. 32614 D.

Cements.

Hydraulic Cements. William S. Macharg. From *The Building Arts.* Comments on the new uses to which this material has been applied. Briefly reviews the history of the modern product, and gives information concerning it. 2000 w. Sci Am Sup—Feb. 24, 1900. No. 32700.

The Measurement of the Variations in Volume of Hydraulic Cements (Mesure des Variations de Volume des Liants Hydrauliques). M. Deval. A general report upon the tests made by a committee of the Society, with tables of the results and diagrams showing the behaviour of various cements. 10000 w. Bull de la Soc d'Encour—Jan. 31, 1900. No. 32-609 G.

The New Works of the Coplay Cement Company. Illustrated description of a plant making 1600 bbls. of Portland cement daily. Traces the progress of the material from the quarry to the storehouse for the finished product, and describes the apparatus and its arrangement. 2400 w. Eng Rec—Feb. 27, 1900. No. 32717.

The Softening of Portland Cement Plaster. An account of the destruction of the lining of water basins in Leipzig and other German cities by the carbonic acid in the water. 1000 w. Eng Rec—Feb. 3, 1900. No. 32312.

Fireproofing.

Wood Fireproofing. Illustrates and describes the process of the American Wood Fireproofing Company of New York. 1000 w. Fire & Water—Feb. 24, 1900. No. 32732.

Quicksand.

Quicksand. A report of statements by a number of engineers, including an analysis of the physical properties of quicksand, and a statement of its true nature. 1700 w. Eng Rec—Feb. 10, 1900. No. 32428.

Tests.

Tests of Small Model Cement Arches to Determine the Value of Tie Rods. Daniel B. Luten. Illustrated description of these tests and discussion of the results. 1400 w. Eng News—Feb. 15, 1900. No. 32515.

See Bridges.

Timbers.

Wood Preserving in Germany. A. G. Wanier. Describes the Hasselmann process and quotes from authorities and experts concerning its advantages and value. 2800 w. R R Gaz—Feb. 9, 1900. No. 32451.

MUNICIPAL.

Garbage.

The Barren Island Garbage Reduction Works, Greater New York. An account of the disposition of the garbage of Greater New York, and an illustrated detailed description of the plants on Barren Is. Also editorial. 7700 w. Eng News—Feb. 1, 1900. No. 32351.

Highway Traffic.

The Restriction of Traffic on Highways. A review of a decision of the Maine Supreme Court that it is unreasonable to force heavily laden wagons from improved roadways, unless suitable roads are provided for them. 700 w. Eng Rec—Feb. 10, 1900. No. 32416.

Pavements.

Brick Pavements from a Contractor's Point of View. George R. Grimes. Abstract of paper read at meeting of the National Brick Mfrs. Assn. Gives the most satisfactory methods of laying brick pavements. 2500 w. Eng Rec—Feb. 24, 1900. No. 32718.

Creosoted Wood Block Pavements in Indianapolis. M. A. Downing. Read before the Am. Soc. for Munic. Inps. Gives an account of the use of this pavement in city named and considers it a success from every point of view. 1500 w. St Ry Rev—Feb. 15, 1900. No. 32510 C.

Brick Paving in Iowa. A statement of the elaborate tests being conducted in that State on the physical and chemical properties of paving brick, the methods of testing them, and the actual resistance of the various brands to travel, in different cities of the State. 2500 w. Eng Rec—Feb. 3, 1900. No. 32314.

Philadelphia.

Philadelphia: What Are Its Needs? Discussion, introduced by H. V. B. Osbourn, of the municipal improvements desirable in this city. Ill. 5000 w. Pro Engs' Club of Phila—Feb., 1900. No. 32744 D.

Quarantine.

Sanitary Methods During the Bubonic Plague in Honolulu. Describes the measures taken by the Board of Health, particularly in the Chinese quarters. 1200 w. Eng Rec—Feb. 17, 1900. No. 32527.

Refuse.

The Modified Horsfall Crematory. Illustrated description of a form of destructor designed to burn very wet city refuse, like swill, sewage sludge or night soil. 700 w. Eng Rec—Feb. 3, 1900. No. 32319.

Roads.

Modern City Roadways. Nelson P. Lewis. Illustrates and discusses the different kinds of paving in general use and the kinds most favored in various cities. 3500 w. Ap Pop Sci M—March, 1900. No. 32736 C.

Santiago.

Sanitary Conquest of Santiago. From *Chicago Sunday Tribune*. An account of the work that has been necessary to make the city a safe dwelling place. 3000 w. Dom Engng—Feb., 1900. No. 32559 C.

Sewage Disposal.

Bacterial Sewage Disposal at East Cleveland. Illustrated description of a plant for treating 150,000 gals. of sewage daily by the Waring system of preliminary filtration, aeration and final filtration. 1600 w. Eng Rec—Feb. 10, 1900. No. 32420.

Results Obtained with the Ames Sewage Disposal Works. A statement of the leading facts found by chemical and bacteriological examinations of the raw and purified sewage at a plant using some storage and then intermittent filtration. 1800 w. Eng Rec—Feb. 24, 1900. No. 32719.

Sewage Disposal at Chichester, England. James H. Fuertes. Illustrates and describes works to store, clarify by chemical treatment, and filter the sewage of a sea-coast town of 4,000 population. 900 w. Eng Rec—Feb. 10, 1900. No. 32421.

Sewage Filtration Through Coal. A review of experiments at Lichfield and Wolverhampton yielding new information on the value of coal for treating the effluents of chemical and septic tanks. 1800 w. Eng Rec—Feb. 3, 1900. No. 32310.

The Iowa State College Sewage Disposal Plant. Illustrated description of works on the intermittent filtration system, in which a partial septic action is obtained by preliminary storage of the sewage. 2500 w. Eng Rec—Feb. 17, 1900. No. 32522.

The Scott-Moncrieff System of Sewage Disposal. Detailed description of the process and of the steps by which its present condition has been reached. Ill. 2500 w. Engr, Lond—Jan. 26, 1900. No. 32373 A.

Street Cleaning.

Street Cleaning Statistics for Forty American Cities. Tabulated information compiled by Andrew Rosewater, of Omaha, Neb. 600 w. Eng News—Feb. 22, 1900. No. 32712.

ELECTRICAL ENGINEERING

COMMUNICATION.

Police Telegraphs.

A New Electrical Police Signaling System. Illustrated description of the Davis system and statement of the advantages claimed. 1000 w. Fire & Water—Feb. 10, 1900. No. 32486.

Fire Alarm and Police Telegraph System, Los Angeles. Illustrated description of a fine automatic system in Los Angeles, Cal., comprising 14 box circuits and 10 gong circuits for the fire alarm system, and 4 signal circuits for the police telegraph system. 1400 w. Elec Wld & Engr—Feb. 17, 1900. No. 32536.

Self Induction.

See Measurement.

Space Telegraphy.

Recent Progress in Wireless Telegraphy. G. Marconi. Abstract of a discourse delivered at the Royal Inst., with editorial comment. On problems recently solved and developments of the last few months. Ill. 5500 w. Elect'n, Lond—Feb. 9, 1900. No. 32566 A.

The Possibilities of Wireless Telegraphy. A topical discussion introduced by Reginald A. Fessenden. Ill. 17400 w. Trans Am Inst of Elec Engs—Dec., 1899. No. 32737 D.

Telephones.

A New Telephone System for Party Lines. Jul. H. West. Illustrates and describes a system allowing the telephones of several subscribers to be connected to the exchange by one common party line. It contains a device for locking all stations on the line except the one in use. 1800 w. Elect'n, Lond—Feb. 2, 1900. No. 32479 A.

Selective Telephone Signals. H. S. Webb. Describes and illustrates a new selective signalling system recently patented by J. A. Barrett. 2500 w. Am Elect'n—Feb., 1900. No. 32291.

The Paris Telephone System (Le Téléphone à Paris). A. Dennery. A very complete account of the new central station at Paris, showing the arrangement of connections and switchboards, and methods of operating, with numerous illustrations. Two articles, 4500 w. Génie Civil—Jan. 20, 27, 1900. No. 32600 each D.

Toll Lines.

The Construction of Toll Lines. Illustrated detailed description of this branch of telephone work, discussing some of the difficulties to be overcome. 5500 w. Tel Mag—Feb., 1900. No. 32-739.

DISTRIBUTION.

Alternating Currents.

The Drop in Alternating-Current Wires. Cecil P. Poole. Presenting facts bearing on this subject and discussing methods of computing. 1700 w. Elec Wld & Engr—Feb. 21, 1900. No. 32727.

Distributing Station.

Central Distributing Station of the Philadelphia Electric Company. C. Walton Swoope. Illustrated description of the system in use since the consolidation. It differs from those in operation in other cities in that more than one permanent generating station will be maintained. 2000 w. Elec Wld & Engr—Feb. 24, 1900. No. 32725.

Three-Wire System.

Improvements in the Three-Wire System. Alton D. Adams. Notes recent improvements which the writer thinks ensure for this system a tendency to displace all other systems of public distribution. 2500 w. Am Elect'n—Feb., 1900. No. 32289.

The Bromley and Chislehurst Electric Lighting System. Illustrated detailed description. 3400 w. Elect'n, Lond—Jan. 26, 1900. No. 32360 A.

Underground Construction.

Electrical Underground Construction. George B. Springer. Illustrated description of various systems, and methods of carrying out the work, with related information. 5000 w. Jour W Soc of Engs —Dec., 1899. No. 32302 D.

Wiring.

The Electric Wiring of Buildings. W. A. Chamen. Abstract of a paper read before the Inst. of Engs. and Shipbuilders, at Glasgow. Considers the different systems in use and their variations, and discusses what is best in the interests of safety. 4600 w. Elect'n, Lond—Feb. 2, 1900. No. 32481 A.

ELECTRO-CHEMISTRY.

Copper Tubes.

An Electrolytic Centrifugal Process for the Production of Copper Tubes. Sherard Cowper-Coles. Read before the Inst. of Elec. Engs. Discusses the progress of electrolytic copper refining, describing the methods for improving the physical properties, the centrifugal process developed by the author, etc. Ill. 5500 w. Elect'n, Lond—Feb. 9, 1900. No. 32565 A.

Electro-Galvanizing.

Some Notes on Electro-Galvanizing. Sherard Cowper-Coles. Illustrates and describes the process, and notes some of its applications. 1600 w. Ind & Ir—Feb. 2, 1900. No. 32477 A.

Electrolysis.

The Decomposition of Common Salt (Zur Kochsalzzerlegung). R. Lorenz and H. Wehrlin. A contribution from the electro-chemical laboratory of the Zürich Polytechnic, giving the results of experiments upon the electrolytic production of hypochlorites and chlorates by the decomposition of common salt. Three articles, 7500 w. Zeitschr f Elektrochemie—Jan. 25, Feb. 1, 8, 1900. No. 32662 each D.

Review.

Electrochemistry in the Year 1899 (Die Elektrochemie im Jahre, 1899). Dr. M. Krüger. A general review of progress in various branches of the art during the past year. 3500 w. Elektrochemische Zeitschr—Feb., 1900. No. 32666 G.

Switchboard.

A Switchboard for the Electrolytic Laboratory (Schalttafeln für Elektrolytische Laboratorien). Fr. Klingelfuss. A convenient design of switchboard for use with continuous lighting current in connection with a small accumulator system. 1200 w. Zeitschr f Elektrochemie—Jan. 18, 1900. No. 32661 D.

Voltaic Cell.

The Theory of the Voltaic Cell. Appended to Prof. A. Righi's lecture on Volta, delivered at Como. An explanation of various phenomena, and of certain theories. 6000 w. Elec Rev. Lond—Feb. 9, 1900. No. 32567 A.

ELECTRO-PHYSICS.

Asynchronous.

The Theory of Asynchronous Motors

(Zur Theorie der Asynchronmotoren). Julius Heubach. A graphical treatment of the general theory of non-synchronous motors; both three-phase and single-phase motors being considered. Two articles, 10,000 w. Elektrotech Zeitschr—Jan. 25, 1900. No. 32654 each B.

Engraving.

An Electrical Engraving Process. N. S. Amstutz. Illustrated description of a mechanism called the acrograph, which does for light what the phonograph does for sound. Specimens of work are also given. 4400 w. Elec Wld & Engr—Feb. 17, 1900. No. 32535.

Hysteresis.

The Hysteretic Qualities of Iron Viewed from the Molecular Magnet Standpoint. Dr. Samuel Sheldon. An interesting account of experiments with watch-charm compass magnets. 1100 w. Elec Wld & Engr—Feb. 10, 1900. No. 32431.

Radiography.

A Method of Measuring the Velocity of Röntgen Rays (Une Methode de Mesure de la Vitesse des Rayons Röntgen). Bernard Brunhes. An adaptation of the property of the X rays upon potential explosives for measuring the velocity. The ordinary methods are not applicable to rays which cannot be reflected. 1200 w. Comptes Rendus—Jan. 15, 1900. No. 32629 D.

Resistance.

The Permanent Modifications of Metallic Wires and the Variation in their Electric Resistance (Les Modifications Permanentes des Fils Metalliques et la Varition de leur Resistance Electriques). H. Chevalier. A communication to the French Academy, giving the results of experiments made at the Physical Laboratory at Bordeaux upon the influence of variations of temperature upon resistance. 1000 w. Comptes Rendus—Jan. 15, 1900. No. 32628 D.

GENERATING STATIONS.

Accumulators.

A Graphical Investigation of the Action of Storage Batteries (Graphische Ermittelung der Leistung von Pufferbatterien). Moritz Kohn. A discussion of the action of a storage battery when used in parallel with a generator, the curves of the dynamo and the battery being combined. 2000 w. Elektrotech Zeitschr—Jan. 25, 1900. No. 32655 B.

Pressure Ratios in Accumulator Plants (Spannungsverhältnisse bei Akkumulatoren-Anlagen). E. Schiff. Discusses the most advantageous rates for charging and discharging storage batteries. 1000 w. Elektrochemische Zeitschr—Feb., 1900. No. 32665 G.

See Mechanical Engineering, Automobilism.

Accumulator Plates.

A Method of Determining the True Surface of Accumulator Plates (Ueber eine Methode zur Bestimmung der Wahren Obenflächen von Akkumulator platten). Konrad Norden. Discussing a method of determining the effective area of any form of accumulator plate by the volume of current yielded, and showing how to apply data thus determined to subsequent designs. 3500 w. Zeitschr f Elektrochemie—Feb. 1, 1900. No. 32663 D.

Austria.

The New Plant of the Witkowitz Company at Dombrau, Austria (Les Nouvelles Installations de la Cie de Witkowitz aux Mines de Dombrau, Austriche). H. Schmerber. A general description, with plate, showing the electric plant in the picking and sorting department of these important Austrian coal mines. 2000 w. 1 plate. Génie Civil—Jan. 20, 1900. No. 32601 D.

The Status of the High Pressure Current Industry in Austro-Hungary (Die Lage der Starkstromindustrie in Oesterreiche-Ungarn). Emil Honigmann. A review of the work of the year 1899, with a complete table of existing plants, giving commercial and technical data of value. 7500 w. Elektrotech Zeitschr—Feb. 8, 1900. No. 32660 B.

Bromley, Kent.

An English Direct Current High Tension Central Station. Illustrated description of a plant recently installed at Bromley, Kent, distributing direct current at high voltage and transforming to service voltage by means of dynamotors. 2000 w. Elec Wld & Engr—Feb. 17, 1900. No. 32534.

Design.

The Designing of Electrical Generating Stations. A. Roberts. Read before the Soc. of Archts., England. Describes a typical station, its construction, and arrangements. 4700 w. Arch't, Lond—Jan. 26, 1900. No. 32357 A.

Dynamos.

Notes on Commutatorless Dynamo Design. H. E. Heath. Describes several forms, giving illustrations, and pointing out the advantage of this type for the production of large currents at low voltages. 1600 w. Elec Wld & Engr—Feb. 10, 1900. No. 32430.

Govan.

Govan Electricity Supply Works. Illustrated description of a three-wire continuous-current system with 250 volts on each side of the middle wire. 2300 w. Elect'n, Lond—Feb. 2, 1900. No. 32480 A.

Induction Motor.

The Polyphase Induction Motor. Ralph D. Mershon. Read at the Milwaukee meeting of the Northwestern Elec. Assn. Explains the salient points in the theory of the induction motor without using mathematics or complicated diagrams, but making clear the underlying principles. Ill. 4000 w. Elec Wld & Engr—Feb. 3, 1900. Serial. 1st part. No. 32350.

London.

Plant of London Metropolitan Electric Supply Company. Illustrates and describes the steam engines and generators, and switchboard. 1600 w. Elec Wld & Engr—Feb. 3, 1900. No. 32349.

Massena, N. Y.

The Power House of the St. Lawrence Power Company, Massena. Illustrated description of the station on the Grasse River, which is designed for an ultimate capacity of 150,000 h.p., half again as much as the capacity of the Niagara Plant at present. The switchboard details are particularly novel. 1800 w. Eng Rec—Feb. 10, 1900. No. 32417.

Power Plant.

A One-Hundred-Thousand Horse-Power Plant. Illustrated detailed description of the power station of the Third Avenue Railroad Company of New York. 5700 w. Power—Feb., 1900. No. 32262.

Regulator.

New Automatic Pressure Regulator (Neuer Selbstthätiger Spannungsregulator). Emil Dick. The regulator is operated by a solenoid acting upon a field resistance. The weight of the solenoid core is counteracted by floating it in mercury. 3500 w. Eletrotech Zeitschr—Jan. 25, 1900. No. 32656 B.

Standardization.

The Standardization of Electrical Engineering Plant. R. Percy Sellon. Read before the Inst. of Elec. Engs., England. Presents the importance and advantages from an English standpoint. 3000 w. Ind & Ir—Feb. 9, 1900. No. 32573 A.

Test.

Test of an Electric Generating Set in the State, War and Navy Building, Washington. G. W. Baird. The experiments were made on a 60 K. W. direct-current compound condensing plant. 1000 w. Eng Rec—Feb. 17, 1900. No. 32531.

HEATING AND WELDING.

Annealing.

The Electric Process of Annealing Armor-Plate in the Construction of War-Ships. Charles J. Dougherty. Treats of the process of the Thomson Electric-Welding Co., of Lynn, Mass. Illustrated description, with discussion. 3000 w. Pro Engs' Club of Phila—Feb., 1900. No. 32743 D.

Furnaces.

Electric Furnaces with Especial Reference to the Production of Calcium Carbide (Ueber Elektrische Oefen, besonders mit Rücksicht auf die Darstellung von Calcium Carbid). Birger Carlson. An examination of the electrical, thermal, and chemical conditions entering into the production of carbide and the best design of furnace for the purpose. Serial. Part 1. 3000 w. Zeitschr f Elektrochemie—Feb. 8, 1900. No. 32664 D.

Rail Welding.

The Goldschmidt Process of Rail Welding. Abstracts of two papers describing this novel and interesting method. Ill. 2000 w. St Ry Jour—Feb. 3, 1900. No. 32332 D.

LIGHTING.

Arc.

Alternating-Current Arc Lighting. E. P. Warner. Read before the Chicago Elec. Assn. Briefly reviews the early history of arc lighting and considers modern practice. 3300 w. Elec Rev, N. Y.—Jan. 31, 1900. No. 32283.

Incandescent.

The Incandescent Electric Light. Gives interesting history, claiming that the original discovery of this light was in Toronto, Canada, and that Dr. Woodward's patent antedates the patent of T. A. Edison and was purchased by him. 3000 w. Can Elec News—Feb., 1900. No. 32507.

Lightning.

The Effects of Lightning Upon Electric Lamps. Sydney Webb and G. G. Stokes. Gives illustrations showing effects obtained when attempting to photograph lightning in a field including arc lamps. 2800 w. Nature—Feb. 8, 1900. No. 32562 A.

Nernst Lamp.

The Predecessors of Nernst (Les Précurseurs de Nernst). L. de Somzée. A brief review of the early inventions in incandescent electric lighting, based upon the conductivity of refractory substances when heated; discussing the extent to which these anticipated the Nernst lamp. 1200 w. L'Electricien—Jan. 20, 1900. No. 32668 B.

Primary System.

Electric Lighting from Primary Batteries. F. E. Woodford. On means of lighting residences in rural districts, and other uses of electricity. 1800 w. Am Elect'n—Feb., 1900. No. 32290.

MEASUREMENT.

Electrometer.

The Addenbrooke Electrometer. Illustrated description of G. L. Addenbrooke's system of alternating-current measurement. 1800 w. Elec Eng, Lond —Feb. 2, 1900. No. 32456 A.

Magnetic Fields.

The Ayrton-Mather Portable Field Tester. Illustrates and describes an apparatus consisting of a search-coil and a ballistic galvanometer, and claiming to obtain angular deflections to 800°. 700 w. Elec Wld & Engr—Feb. 10, 1900. No. 32432.

Meter.

Multiple Dial Electric Meter (Compteur Horaire d'Electricité à Cadrans Multiples). M. Aliamet. A description of the Villy meter. One clock work mechanism is provided with a number of dials, each of which may be connected with a different circuit. 1200 w. L'Electricien—Jan. 20, 1900. No. 32667 B.

Self Induction.

Measurements of the Self-Induction of Submarine Cables. Dr. F. Breisig. From the *Elektrotechnische Zeitschrift.* A communication from the Testing Office of the German Government Telegraphs. Describes the method of measurement, the conductors tested, results, etc. 2500 w. Elect'n, Lond—Feb. 2, 1900. No. 32482 A.

Units.

A Proposed System of Units. Reginald A. Fessenden. Shows the desirability of having electrical units, rationalized, and suggests an intermediate solution of the difficulty. Also editorial. 3500 w. Elec Wld & Engr—Feb. 24, 1900. No. 32726.

POWER APPLICATIONS.

Canal Traction.

Electric Traction on Canals (La Traction Electrique sur les Canaux). R. Dubreuil. With descriptions and illustrations of the various devices used in France, Germany, and elsewhere, and data of the results of practical operation. 3000 w. Revue Technique—Jan. 10, 1900. No. 32604 D.

Crane.

Electric Radial Crane of 150 Tons Capacity at the Harbour of Bremerhaven (Grue Pivotante Electrique de 150 Tonnes, du Port de Bremerhaven). A full detailed description of this powerful electric crane, of 72 feet maximum radius, and electric movements throughout. 2000 w. 1 plate. Génie Civil—Feb. 3, 1900. No. 32602 D.

Factory Plants.

Continuous and Multiphase Power Plants for Factory Use. Examines the advantages and difficulties of multiphase power plants, concluding that from the plants inspected it was difficult to perceive any advantage over the continuous system. 2500 w. Elec Rev, Lond—Jan. 26, 1900. No. 32361 A.

Lock Gates.

See Civil Engineering, Hydraulic.

Locomotive.

See Street and Electric Tramways.

Powder Works.

Electrical Equipment of United States Government Powder Factories. Illustrates and describes the plant being installed at the Indian Head factory. 1800 w. Engng—Jan. 26, 1900. No. 32379 A.

Printing.

The Electrical Equipment of the Printing Establishment of the "St. Louis Republic." George A. Damon. Illustrated detailed description of the plant. 2500 w. Am Elect'n—Feb., 1900. No. 32285.

Steering Gear.

Electrical Steering Gear for Ships. Illustrations and explanation of the machinery and wiring and how it works. Four Russian war ships are to be fitted with the electrical steering gear. 1800 w. Marine Rev—Feb. 8, 1900. No. 32449.

TRANSMISSION.

Conductors.

A Graphical Representation of the Flow of Alternating Currents in Long Conductors (Ueber die Graphische Darstellung des Verlaufes von Wechselströmen längs Langer Leitungen). Dr. F. Breisig. A paper read before the Berlin Electrotechnical Society, giving an analytical and graphical discussion, and describing a model for illustrating the wave action. 6000 w. Elektrotech Zeitschr—Jan. 25, 1900. No. 32657 B.

Mount Whitney.

The Mount Whitney Power Transmission. Robert McF. Doble. Interesting illustrated description of this modern and finely equipped installation, with account of its construction. 6500 w. Jour of Elec —Jan., 1900. No. 32498.

Power Economics.

The Economics of Long Distance Electric Power Transmission. Alton D. Adams. Discusses the prospectus of a company in Western Illinois, showing the falsity of the claims made, and of similar claims concerning the transmission of power over long distances. 2200 w. Eng News—Feb. 1, 1900. No. 32353.

Transformation.

The Transformation of Niagara Power Into Three-Wire Direct Current by the Buffalo General Electric Company. Illustrations with complete description of circuits and explanations of unusual alternating-current phenomena involved. 5500 w. Am Elect'n—Feb., 1900. No. 32284.

GAS ENGINEERING

Acetylene.

The Official Report of the Budapest International Acetylene Exhibition and Congress. Comments on this report, and information gathered from it. 1500 w. Engr, Lond—Feb. 2, 1900. No. 32466 A.

The Second International Acetylene Exposition at Budapest, 1899 (Die Zweite Internationale Acetylen-Austellung in Budapest, 1899). Karl Neudeck. A complete review of the exposition, with plan of the building, and illustrated descriptions of the various exhibits, forming a complete account of the present status of the subject. Three articles, 8000 w. Zeitschr d Oesterr Ing w Arch Ver—Jan. 12, 19, 26, 1900. No. 32622 each B.

Address.

Inaugural Address of Mr. Henry O'Connor, before the Society of Engineers. Observations on the developments in gas engineering during recent years. 8500 w. Jour Gas Lgt—Feb. 6, 1900. No. 32483 A.

Coal-Gas.

The Manufacture of Coal-Gas. Illustrated detailed description of process using fuel-gas for heating the retorts, and describing various devices in use. 2500 w. Sci Am Sup—Feb. 10, 1900. No. 32405.

Deposits.

The White Deposit on Ceiling-Protectors and on the Chimneys of Incandescent Gas Burners. On the researches made by Dr. C. Killing and published in the *Journal für Gasbeleuchtung*. 2000 w. Jour Gas Lgt—Feb. 13, 1900. No. 32716 A.

Ferrocyanides.

A Method for the Estimation of Ferrocyanides in Old Purifying Material. E. Donath and B. M. Margosches, in *Zeitschrift für Angewandte Chemie*. Describes the process and method of applying to old purifying material. 1200 w. Am Gas Lgt Jour—Feb. 19, 1900. No. 32538.

Fuel Gas.

Some Notes on Gas as a Fuel. Discusses coal and its combustion and the loss in heating power in making "producer" gas. 2200 w. Ir & Coal Trds Rev—Feb. 2, 1900. No. 32470 A.

Furnace Gas.

The Use of Blast Furnace Gas for Power Purposes. W. H. Booth. Considers the important facts when it is proposed to utilize blast-furnace gas as a means of power generation, and gives related information. 1400 w. Am Mach—Feb. 8, 1900. No. 32400.

Gas Works.

A de Brouwer Coke-Conveyor and a Carburetted Water-Gas Plant at the Crystal Palace Gas-Works. Illustrated description of these improvements. 5000 w. Jour Gas Lgt—Jan. 23, 1900. No. 32358 A.

"Kugel" Light.

The Illuminating Power and Color of the "Kugel" High-Pressure Gas Light. Dr. H. Bunte and Dr. P. Eitner, in the *Journal für Gasbeleuchtung*. An account of an exhaustive investigation of this high-pressure gas light, directed chiefly to the points named. 2700 w. Jour Gas Lgt—Jan. 30, 1900. No. 32459.

Photometry.

German Views of Gas Photometry. On gas testing in Germany, Austria and France, showing much diversity of methods, even among different cities of Germany. 1700 w. Jour Gas Lgt—Jan. 30, 1900. No. 32458 A.

Pintsch Gas.

The Oil Gas Plant at Hütteldorf, near Vienna (Die Oeglas-Anlage in Hütteldorf bei Wien). Franz Walter. Including a general discussion of the manufacture of illuminating gas from oil, and a fully illustrated description of this modern plant for producing and compressing the gas for use in train lighting. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst —Jan., 1900. No. 32650 D.

MARINE AND NAVAL ENGINEERING

Battleship.

United States Battleship Maine. A description of the new Maine. 2200 w. Marine Rev—Feb. 8, 1900. No. 32442.

Boilers.

Boilers for Big Ships. On the design of Babcock and Wilcox steam generators that are being installed in nine modern freighters of the Great Lakes, with reports of tests made by U. S. Navy Bureau of Steam Engineering. 1300 w. Marine Rev —Feb. 8, 1900. No. 32448.

Cargo Steamers.

The Distribution of Materials in the

Upper Works of Large Steamers. Samuel J. P. Thearle. Read before the North-East Coast Inst. of Engs. and Shipbuilders. Changes made necessary by the growing tendency to build very many large cargo steamers, and to place extensive superstructure upon them are discussed. Ill. 3800 w. Engr, Lond—Feb. 9, 1900. No. 32580 A.

Coaling Stations.

The United States Foreign Coaling Stations. Information from the recent report of Admiral Bradford, of the U. S. Navy, showing the importance of the coal trade and coaling stations in naval matters. 2000 w. Ir & Coal Trds Rev—Feb. 2, 1900. No. 32472 A.

Deutschland.

The Express Steamer "Deutschland" (Der Schnelldampfer "Deutschland"). A general description of the vessel, with views of the work of construction in progress, and of the engines erected in the works; also an account of the ceremonies of the launch. 1800 w. Stahl und Eisen —Jan. 15, 1900. No. 32640 D.

Disinfecting.

Disinfecting Ships. C. M. Green. On the development of the government work of disinfecting vessels, crew, passengers and baggage to prevent the spread of infectious diseases; describes the Sanator, a modern vessel for this work. Ill. 4500 w. Marine Rev—Feb. 15, 1900. No. 32537.

French Navy.

A New French Naval Scheme. Editorial comment on the programme of 1896, and on the programme to be soon submitted to Parliament. 1700 w. Engr, Lond—Feb. 9, 1900. No. 32577 A.

Ice Breakers.

Ice Breakers in Polar Exploration. Edwin Swift Balch. An account of the "Yermak" and her voyages, and the value of this means of penetrating the polar regions. 1000 w. Jour Fr Inst—Feb., 1900. No. 32414 D.

Ironclad.

The New Dutch Ironclad Koningin Regentes. Illustrations, with brief description. 500 w. Engr, Lond—Feb. 9, 1900. No. 32576 A.

Marine Congress.

International Marine Congress at Paris. The programme of the Congress to be held during the Exposition of 1900. 900 w. U. S. Cons Repts, No. 654—Feb. 14, 1900. No. 32464 D.

Mechanical Stokers.

Mechanical Stokers, S.S. Pennsylvania. Describes the principal features of this vessel, engaged in the carriage of freights on the Great Lakes, and gives illustrated description of the stokers, with report of tests. 3800 w. Engr, Lond—Jan. 26, 1900. No. 32377 A.

Naval Development.

Tendencies of Foreign Naval Development. George H. Peters. A review of foreign views and tendencies as represented in the press and other publications. 4500 w. Naut Gaz—Feb. 22, 1900. No. 32589.

Ore Carrying.

The Ore Carrying Fleet of 1900. Waldon Fawcett. Illustrates and describes the ships that will transport the 20,000,000 tons on the lakes. 1600 w. Am Mfr & Ir Wld—Feb. 1, 1900. No. 32296.

River Steamer.

Magnificent River Steamer. Illustrated description of the Tashmoo, a vessel similar to Hudson River boats, building at Detroit for service on St. Clair and Detroit rivers. 900 w. Marine Rev—Feb. 8, 1900. No. 32445.

Ship Building.

From Lakes to Seaboard. A view of conditions presented to ship builders of the Great Lakes and the Atlantic coast by the opening of Canada's St. Lawrence River canals, and the proposed New York State canal improvements. Ill. 1700 w. Marine Rev—Feb. 8, 1900. No. 32447.

Shipbuilding and Marine Engineering in 1899. Benjamin Taylor. A comprehensive review of the work of the past year, showing the remarkable mechanical achievements in one of the greatest of engineering industries. 4500 w. Engineering Magazine—March, 1900. No. 32686 B.

Ship Building Industry in America. Gives tabulated report of vessels under construction, and other information showing a prosperous condition. 1800 w. Marine Rev—Feb. 8, 1900. No. 32441.

Ships.

Ships and Their Makers. An illustrated account of the Clydebank shipyard and the vessels built there. 8000 w. Commerce—Feb. 7, 1900. No. 32590 A.

Shipyards.

Full Share of Prosperity. Summary of the year's work at the Newport News shipyard, with illustrations. 800 w. Marine Rev—Feb. 8, 1900. No. 32446.

Newest Practice in American Shipyard Appliances. Waldon Fawcett. On the recent development in the equipment of shipyards, calling attention to innovations adopted in various yards and reforms in methods. 2500 w. Ir Age—Feb. 22, 1900. No. 32713.

Where the New Maine is Building. Illustrated description of important improvements at the Philadelphia works of

Wm. Cramp & Sons Co. 2800 w. Marine Rev—Feb. 8, 1900. No. 32443.

Steamships.

Additions to Fleet of the Cunard Line—S.Ss. Saxonia and Iverina. Illustrated description of vessels for the Boston-Liverpool service. 600 w. Marine Engng—Feb., 1900. No. 32388 C.

Steering Gear.

See Electrical Engineering, Power.

Tenders.

New Light-House Tenders. Illustrated description of the Heather, to be built for Oregon coast service. 700 w. Marine Rev—Feb. 8, 1900. No. 32444.

Transport Service.

Work of the U. S. Army Transport Service at San Francisco, Cal. An illustrated account of difficulties met and conquered in the transportation of 40,000 troops across the Pacific to the Philippines. 1800 w. Marine Engng—Feb., 1900. No. 32387 C.

Warships.

The Modern Warship, as Combining in Itself the Highest Results of Skill, Ingenuity and Scientific Knowledge. George W. Melville. An address delivered on the occasion of the celebration of the seventy-fifth anniversary of the Franklin Inst. 6500 w. Jour Fr Inst—Feb., 1900. No. 32413 D.

Yachts.

American Builders of Steam Yachts. An illustrated article showing the rapid development of this branch of ship-building, that has extended to nearly all of the principal yards. 2000 w. Marine Rev—Feb. 22, 1900. No. 32724.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Competitive Tests of Accumulators in France. A. de Courcy. A brief account of tests made by the Automobile Club of France. Ill. 700 w. W Elect'n—Feb. 3, 1900. No. 32301.

The Storage Battery from the Standpoint of the User. W. M. Hutchinson. The writer's views of electrically propelled vehicles, after 18-months' personal experience, with a brief explanation of his method of keeping in order and caring for a vehicle battery. Ill. 2000 w. Horseless Age—Jan. 31, 1900. No. 32293.

English Vehicles.

English Electrical Vehicles. Brief illustrated description of the Electric Motive Power Company's dog-cart. 700 w. Ind & Ir—Jan. 26, 1900. No. 32362 A.

European Types.

European Types of Electric Automobiles. Illustrated descriptions of vehicles made by several of the more important manufacturers abroad. 1300 w. Elec Wld & Engr—Feb. 10, 1900. No. 32429.

Fore-Carriage.

Solignac's Electric Fore-Carriage. From *La Nature*. Illustrates and describes an apparatus recently presented to the Société des Voitures Electriques, of Paris. 600 w. Sci Am Sup—Feb. 24, 1900. No. 32599.

Gasoline Motors.

Gasoline Motors for Automobiles. George Kellogg Barrett. Outlines the features to be kept in mind in designing a gasoline engine for automobile use. 1800 w. Mod Mach—Feb., 1900. No. 32346.

Motive Power.

Compressed Air versus Steam for Motor Vehicles. Henry F. Bryant. Gives results of investigations which generally favor steam as a motive power. 3200 w. Horseless Age—Jan. 31, 1900. No. 32292.

Motor Trials.

The Motor Competition of the "Locomotion Automobile" (Le Concours de Moteurs de la "Locomotion Automobile"). Gaston Sencier. With details of the methods of testing, and tabulated data of the results; these relating to internal combustion motors of various kinds. Two articles, 6000 w. Revue Technique—Jan. 10, 25, 1900. No. 32605 each D.

Motor Vehicle.

The "Balmoral" Motor Char-a-Banc. Illustrated description of a conveyance carrying 16 persons, and fitted with a two-cylinder, horizontal, petroleum-spirit motor. 900 w. Ind & Ir—Feb. 9, 1900. No. 32574 A.

The "New Orleans" Motor-Voiturette. Brief illustrated description. 500 w. Ind & Ir—Feb. 2, 1900. No. 32478 A.

HYDRAULICS.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Pumps.

Some Recent Improvements in Worthington Pumping Machinery. Edward C. R. Marks. From a paper read before the Birmingham Assn. of Mechanical Engs. Illustrated description of these improvements, with a statement of the advantages. 2000 w. Prac Engr—Feb. 9, 1900. No. 32593 A.

Speed Variations in Fly Wheel Pumps (Der Ungleichförmigkeitsgrad von Schwungradpumpen). F. Wimbersky. A graphical analysis of the action of the fly wheel in regulating the speed of single, double, and triple acting pumps. 1200 w. Zeitsch d Ver Deutscher Ing—Jan. 27, 1900. No. 32617 D.

MACHINE WORKS AND FOUNDRIES.

Bearings.

Some Causes of Excessive Heating in Bearing Metals. Robert Job. Showing the importance of the microscope in studying these alloys. Ill. 3000 w. Am Engr & R R Jour—Feb., 1900. No. 32270 C.

Blue-Printing.

An Interesting Example of a Modern Blue-Printing Room. Illustrates one of the most elaborate and expensive blue-printing rooms, recently built at the works of the Brown Hoisting and Conveying Machine Co., at Cleveland, O. 1000 w. Eng News—Feb. 22, 1900. No. 32710.

Brass.

The Brass Industry in the Naugatuck Valley. Reviews the present condition of this industry and the causes. 1400 w. Ir Age—Feb. 15, 1900. No. 32489.

Castings.

Casting a Six-Way Pipe Without a Pattern. Jas. A. Murphy. Illustrated directions for the work. 1000 w. Am Mach—Feb. 22, 1900. No. 32596.

The Casting of a Lathe Bed. R. H. Palmer. Illustrates and describes the casting of a lathe bed 27 feet long. 8000 w. Foundry—Feb., 1900. No. 32495.

The Manufacture of Steel Castings. J. E. Fletcher. From a paper read before the Manchester Assn. of Engs. Examines the design of castings used in machine construction, pointing out where the difficulties occur, and suggesting how to overcome them. Ill. 4000 w. Foundry —Feb., 1900. No. 32497.

Cast Iron.

See Mining and Metallurgy, Iron and Steel.

Crane Girder.

Calculations for a Crane Girder. A. D. Williams. Considers one particular girder, showing how the formulas met with in the "pocket books" were applied. 2000 w. Am Mach—Feb. 8, 1900. No. 32396.

Cranes.

Cantilever Cranes. Waldon Fawcett. Illustrated account showing the development and the great saving of time and money. Also notes the principal uses of these cranes. 2000 w. Sci Am—Feb. 10, 1900. No. 32403.

150-Ton Electric Crane at the Imperial Dock in Bremerhaven, Germany. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrated detailed description of the largest crane in the world. 2700 w. Eng News—Feb. 8, 1900. No. 32411.

Overhead Cranes for Handling Material in Bulk (Hochbahnkrane zum Umladen und Aufstapeln von Massengütern). H. Ernst. Especially discussing the various forms of overhead conveyers for handling material in loading and unloading vessels, as extensively used in the United States. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1900. No. 32-618 D.

See Electrical Engineering, Power.

Crank Shafts.

Crank Shafts for Large Engines. W. H. Booth. A reply to criticisms of a former article, with an explanation of the writer's views. Ill. 1500 w. Am Mach —Feb. 15, 1900. No. 32492.

Cylinders.

Cylinders Under Internal Pressure. Alfred Petterson. Gives results of the writer's investigations, examining formulas. 1800 w. Am Mach—Feb. 15, 1900. No. 32493.

Design.

Notes on Machine Design (Betrachtungen über die Maschinen und den Maschinenbau). Ernst A. Brauer. An address before the technical high school at Karlsruhe, discussing the relation of the engineer and his education to his work, especially relating to the department of machine design. 5000 w. Zeitschr de Ver Deutscher Ing—Jan. 27, 1900. No. 32-616 D.

Forging Machine.

A Powerful Pneumatic Forging Machine. Illustrates and describes a machine used in the Burnside shops of the Ill. Cent. Ry., designed by Martin Kennedy. 900 w. Ry & Engng Rev—Feb. 24, 1900. No. 32740.

Foundry Iron.

Foundry Iron. Herbert Pilkington. Abstract of a paper read before the South Staffordshire Iron & Steel Inst. On the need of iron-founders, in England, becoming more familiar with the chemical constituents of their iron, and the behavior of iron of given analysis. 2500 w. Ir & Coal Trds Rev—Jan. 26, 1900. No. 32-370 A.

Flywheels.

Molding a Flywheel. R. H. Palmer. Illustrates and describes the work. 1600 w. Am Mach—Feb. 8, 1900. No. 32398.

Index Plate.

Originating an Index Plate. Illustrates

and describes the work as carried out at the Pope Mfg. Co.'s works. 1400 w. Am Mach—Feb. 1, 1900. No. 32279.

Iron Foundry.

The Walker & Pratt Foundry at Watertown, Mass. Illustrated detailed description of a very fine plant. 3000 w. Am Mach—Feb. 1, 1900. No. 32278.

Jigs.

Jigs for Drilling Sprocket Wheels. A. G. Miles. Sketches showing a pair of tandem sprockets and the two jigs for drilling the same, so that when the smaller one is mounted upon the larger one they shall revolve true together. Describes the operation. 700 w. Am Mach—Feb. 22, 1900. No. 32598.

Lathes.

Improved Bench Lathe. Illustrated description of the Cataract bench lathe. 700 w. Am Mach—Feb. 15, 1900. No. 32494.

Liquid Pressure.

Liquid Operated Machine Tools. H. A. Coombs. A review of patents showing what has been accomplished in this line. 2500 w. Am Mach—Feb. 1, 1900. No. 32281.

Lobed Wheels.

A New Method of Deriving Holditch's Interchangeable, Elliptical, Lobed Wheels, Together with a Simple Geometrical Demonstration of Their Rolling Properties. H. W. Rasche. Illustrated demonstration of method. 1400 w. Am Mach—Feb. 8, 1900. No. 32397.

Purchasing.

Functions and Organisation of the Purchasing Department. Hugo Diemer. A discussion of a very important factor in successful works management. 2000 w. Engineering Magazine—March, 1900. No. 32681 B.

Secretiveness.

The Policy of Secretiveness in Industrial Works. A. E. Outerbridge. A comparison of European and American practice in regard to exclusiveness in access to workshops, showing the gradual assimilation of the practice on both sides of the Atlantic. 3000 w. Engineering Magazine—March, 1900. No. 32684 B.

Shaper.

A Shaping Machine with Novel Features. Illustrated description. 700 w. Am Mach—Feb. 1, 1900. No. 32280.

The Stockbridge Shaper. Illustrated description of a new shaper having points of novelty and interest. 500 w. Am Mach—Feb. 22, 1900. No. 32595.

Shop Practice.

The Revolution in Machine Shop Practice. Henry Roland. Mr. Roland's concluding paper discusses the machine shop of the immediate future, showing the probable modifications which may result from the general introduction of automatic tools and repetitive methods. 2000 w. Engineering Magazine—March, 1900. No. 32687 B.

Shop Ventilation.

See Architectural Engineering, Heating and Ventilation.

Tinning.

Tinning Process for Iron Ware. Describes a tinning process for iron castings. 1300 w. Am Mach—Feb. 22, 1900. No. 32597.

Workshops.

The Ranelagh Works, Ipswich. Illustrated description of fine English shops and their equipment. 3500 w. Engng—Feb. 9, 1900. Serial. 1st part. No. 32-583 A.

POWER AND TRANSMISSION.

Air Compressors.

The Speed of Air Compressors. Frank Richards. A discussion of the proper speed of an air compressor, written in reply to an inquiry. 1300 w. Am Mach—Feb. 8, 1900. No. 32395.

Bicycles.

The Running Gear of Bicycles (Die Bewegungs-mechanismen des Fahrrades). R. Frank. A general detailed discussion of the various portions of bicycle driving gear. The first portion is devoted to the theory and practice of ball-bearing construction. Serial. Part 1. 4500 w. Zeitschr d Ver Deutscher Ing—Jan. 27, 1900. No. 32615 D.

Clutch.

A Large Magnetic Clutch. Illustrated description of a magnetic clutch used to transmit 3000 h. p. in a St. Louis station. 600 w. Eng Rec—Feb. 3, 1900. No. 32320.

Elevators.

The Pneumatic Elevator Safety. J. J. Swann. Illustrates and describes an application of an air brake to elevators. 1500 w. Compressed Air—Feb., 1900. No. 32392.

Gears.

Gearing for the Reduction of Angular Velocity. From *La Nature*. Particulars and illustrations of the Humpage Epicycloidal angular velocity reducer with progressive gearing. 1100 w. Sci Am Sup —Feb. 17, 1900. No. 32506.

Some Things Seen at the Works of the Fellows Gear Shaper Company—New Features of the Gear Shaper. Illustrated description of interesting tools. 1600 w. Am Mach—Feb. 15, 1900. No. 32491.

The Fellows Spur-Bevel Gear. Illustrated detailed description of a curious gear. 1100 w. Am Mach—Feb. 22, 1900. No. 32594.

SPECIAL MOTORS.

Gas Engines.

Gas and Oil Engines. A discussion of engines of this class, explaining fundamental principles, design and operation. Ill. 1700 w. Power—Feb., 1900. Serial, 1st part. No. 32263.

Gas Engine Guarantees Technically Considered. William T. Magruder. Abstract of a paper read before the National Assn. of Gas and Gasoline Engine Mfrs. Considers power ratings, regulation, cost of running and fuel consumption. 2800 w. Am Mach—Feb. 8, 1900. No. 32399.

Gas Engine Plant in Lake Michigan. Brief illustrated description of the new intake crib located six miles from Chicago, its construction, and the electric-lighting equipment. 1200 w. Mod Mach —Feb., 1900. No. 32345.

The Future of Electrical Supply. Alton D. Adams. A discussion of the advantages of the gas engine as a motive power for electrical generating stations, and of the economy of gas as a means of transmitting power. 3000 w. Engineering Magazine—March, 1900. No. 32682 B.

Gasoline Motors.

See Mechanical Engineering, Automobilism.

Gas Power.

Gas Engine Driving for Electric Plants (Elektrizitätswerke mit Gasmachinenbetrieb). M. Krone. A critical comparison of the cost of operating generating stations by gas engines using producer gas, with steam engines and boilers, showing the economy of the former method. A description of the Clausthal plant is given. 6000 w. Zeitschr d Ver Deutscher Ing—Jan. 13, 1900. No. 32612 D.

STEAM ENGINEERING.

Boilers.

Engine Room Practice. E. P. Gould. Special reference is made to the care of boilers. 1800 w. Marine Rev—Feb. 8, 1900. No. 32450.

See Marine Engineering.

Chimney.

A Chimney at the Paris Exposition. Illustrated description of a highly ornamental stack 289 feet high and from 15 to 20 feet in diameter inside. 1300 w. Eng Rec—Feb. 17, 1900. No. 32530.

Efficiency.

Increasing the Efficiency of Steam Engines. Description of experiments by Prof. E. Josse of Germany with a process for utilizing the heat of exhaust steam for evaporating another liquid having a lower boiling point than water. Ill. 1500 w. U. S. Cons Repts, No. 663—Feb. 26, 1900. No. 32733 D.

Engine Testing.

A Pumping Engine Test. An account of the second test made by W. F. M. Goss of the 20,000,000-gal. triple-expansion pumping engine built for the Indianapolis Water Co. Gives a summary of the engine's dimensions and of facts derived from the test. 1700 w. R R Gaz—Feb. 23, 1900. No. 32703.

Engine Tests. George A. Barrus. Describes methods of measuring feed water, indicating, and the general scheme of a feed-water test. 4200 w. Eng Rec—Feb. 17, 1900. Serial. 1st part. No. 32528.

Furnaces.

The Computation of Furnaces (Die Berechnung der Feuerungen). Ed. Brauss. A discussion of the best proportions for furnaces, flues, and chimneys for steam boilers, in order to obtain perfect combustion and absence of smoke production. 3000 w. Gesundheits-Ingeneiur—Jan. 31, 1900. No. 32636 B.

Mechanical Stokers.

See Marine and Naval Engineering.

Multiple Expansion.

A Study of the Action of Multiple Expansion engines (Etude du Fonctionnement des Moteurs à Plusieurs Cylindres). M. E. Lefer. A general examination of the action of steam in several cylinders, with the aid of theoretical diagrams. Numerous examples are worked out for various cylinder ratios. 20,000 w. Bull de la Soc d'Encour—Jan. 31, 1900. No. 32610 G.

Drop in Multiple Expansion Engines. Editorial discussion of a paper by B. L. Weighton, read before the North-East Coast Inst. of Engs. and Shipbuilders. 2200 w. Engr, Lond—Jan. 26, 1900. No. 32376 A.

Pumping Engines.

Pumping Engine at a Westphalian Colliery. Bergassessor von Sobbe. From *Zeitschrift für Berg-Hutten-und Salinenwesen.* Illustrated description of engines used in recovering the Royal Ibbenbüren Colliery. 1200 w. Col Guard—Feb. 9, 1900. No. 32581 A.

Trials of Two Pumping Engines. Report of two trials made by Prof. Wm. Cawthorne Unwin of a pair of triple-expansion vertical pumping engines supplied to the Leeds water-works. 5000 w. Engr, Lond—Feb. 9, 1900. No. 32579 A.

Steam.

The Quality of Steam. Editorial discussion of means to secure the purity of steam, and dry steam. 1700 w. Engr, Lond—Feb. 9, 1900. No. 32578 A.

Steam Engine.

A Giant Steam Engine at the Exposition (Une Machine à Vapeur Géante à l'Exposition). A. Mahoudeau. An illustrated description of the 2500 h. p. triple-expansion engine to be exhibited by Borsig, of Berlin, driving the Siemens & Halske electric generators. 1200 w. Revue Technique—Jan. 25, 1900. No. 32607 D.

Superheating.

The Advantages of Superheating and the Superheater of the University of Liege. Georges Duchesne. Considers the advantages and inconveniences of superheating and describes the superheater at Liege, giving some results obtained. 1700 w. Am Elect'n—Feb., 1900. No. 32288.

Switzerland.

Steam Engine Building in Switzerland. A. Stodola. An interesting account of the remarkable development of engine building under seemingly adverse conditions, with numerous illustrations of the products of the leading builders of Switzerland. 4000 w. Engineering Magazine—March, 1900. No. 32683 B.

Valve Gear.

New Valve Gear for Steam Engines. Illustrated description of the Lang valve gear, which is reported as giving satisfactory results on marine and stationary engines to which it has been applied. 1200 w. Eng News—Feb. 15, 1900. No. 32520.

MISCELLANY.

Education.

Evolution of Technical Education in Economics, Politics, Statecraft and Morals. Robert H. Thurston. An address at the meeting commemorating the seventy-fifth anniversary of the Franklin Inst. 14000 w. Jour Fr Inst—Feb., 1900. No. 32412 D.

Guns.

Our Guns and Their Uses in War. A discussion of British guns and their fittings. 3000 w. Engr, Lond—Feb. 2, 1900. No. 32465 A.

Vickers' Automatic 14-Pounder Gun. Illustrated description of a gun built for the United States Government. 1100 w. Engng—Feb. 9, 1900. No. 32584 A.

Indexing.

A Decimal Index to Mechanical Engineering Literature. Describes the system of the Dept. of Mech. Engs., Univ. of Illinois. 2000 w. Eng Rec—Feb. 17, 1900. No. 32532.

Iron Barrels.

How May Iron Barrels Be Satisfactorily Constructed to Avoid Accidents? (Wie Werden Zweckmässig Schmiedeiserne Transportfässer Hergestellt um Unfälle zu Verhüten?) H. Claussen. Showing that the use of electric welding for the joints of wrought iron barrels does not offer a sufficient strength, unless reinforced by riveting. 1800 w. Glaser's Annalen—Jan. 15, 1900. No. 32644 D.

Liquid Air.

The Technical Applications of Liquid Air (Ueber die Anwendbarkeit Flüssiger Luft in der Technik). Carl Linde. A discussion of the various possible uses of liquid air, as a source of power, as an explosive, as a means of producing oxygen, etc., etc. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 20, 1900. No. 32613 D.

Machine Labor.

Hand and Machine Labor. The first of a series of articles based on the report of the Commissioner of Labor of the United States, concerning the effect of the use of machinery upon labor and cost of production, on wages, etc. 2700 w. Engng—Jan. 26, 1900. Serial. 1st part. No. 32378 A.

Manometer.

Differential Manometer with Photographic Registering Device (Ueber Differential-Manometer mit Photographischer Registrier-Vorrichtung). Paul Fuchs. Illustrated description of a photographic registering device, adapted for use with pressure gauges, thermostats, gas composimeters, etc. 2500 w. 1 plate. Gesundheits Ingenieur—Jan. 15, 1900. No. 32635 B.

Pneumatics.

Pneumatic Engineering. Editorial review of the various applications of compressed air. 1600 w. Engng—Feb. 9, 1900. No. 32586 A.

The Law of Resistance of the Air to the Motion of Projectiles (Sur la Loi de la Résistance de l'Air au Mouvement des Projectiles). Paul Vielle. A discussion of the wave formations in the air accompanying the flight of projectiles; with tables of pressures, velocities and temperatures. 1500 w. Comptes Rendus—Jan. 29, 1900. No. 32631 D.

Refrigeration.

Brewery Refrigeration. E. Brueckner. Illustrated description of the refrigerating plant in R. Leicht's brewery at Vaihingen, Germany. 1200 w. Ice & Refrig—Feb., 1900. No. 32321 C.

Chloride of Calcium in Refrigeration. Madison Cooper. On its value as an absorbent and purifier for cold storage rooms. Ill. 3400 w. Ice & Refrig—Feb., 1900. No. 32322 C.

Thermodynamics.

Thermal Lines on the Isometric Planes. Lays down the common "thermal lines" of thermodynamic graphics in such a manner that they may all be exhibited at once and their peculiar characteristics compared. Ill. 1100 w. Sib Jour of Engng—Feb., 1900. No. 32556 C.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

Coal Analysis. A review of the final report of the Committee of the American Chemical Society on Coal Analysis, giving a description of all their recommendations which differ from the usual practice. 2200 w. Eng Rec—Feb. 10, 1900. No. 32424.

Coaldust.

The Ignition of Coaldust by Electricity. Sydney F. Walker. Discusses the possibility of an arc lamp, or a glowing wire, igniting an atmosphere of coaldust, and the safety of electrical supply in coal mines. 2000 w. Col Guard—Jan. 26, 1900. No. 32365 A.

Coal Working.

Working by Panels and Intermediate Stages of Three Stopes at the Commentry Colliery. M. Martinet. From a communication to the Société de l'Industrie Minerale. Illustrated description of the system named. 3000 w. Col Guard—Feb. 2, 1900. No. 32476 A.

Coke.

Relation of Coke Producers to Consumers. E. M. Peters. Read before the Cent. Min. Inst. of W. Penn. The importance of the industry is considered and how to produce what the consumer requires. 2000 w. Mines & Min—Feb., 1900. No. 32342 C.

Coke Plant.

The Semet Solvay Coke Plant at Dunbar, Pa. William L. Affelder. Illustrated description of the coke ovens and the apparatus for the recovery of the by-products. 2200 w. Mines & Min—Feb., 1900. No. 32336 C.

Connellsville.

The Connellsville Coking Region. F. C. Keighley. Read before the Cent. Min. Inst. of W. Penn. A history of the development and an account of the wonderful production. 4500 w. Mines & Min—Feb., 1900. No. 32341 C.

Deep Beds.

A New Method for Working Deep Coal Beds. H. M. Chance. Describes a new system, illustrating by plate, and gives suggestions for its operation. 2000 w. Trans Am Inst of Min Engs—Feb., 1900. No. 32547 D.

Eureka Mines.

The Largest Collieries in the United States. Burcham Harding. Illustrated account of the Eureka Mines, near the center of Pennsylvania. 1400 w. Eng & Min Jour—Feb. 17, 1900. Serial. 1st part. No. 32539.

Fiery Mines.

Methods of Working in Fiery Brown-Coal Seams. H. Winklehner. From *Allegemeine bergmännische Zeitschrift.* Illustrates and describes special methods of working introduced in a mine in Hungary. 2000 w. Col Guard—Jan. 26, 1900. No. 32366 A.

France.

The Coal Basin of Gard and the Phenomena of Drift (Le Bassin Houiller du Gard et les Phénomènes de Charriage). Marcel Bertrand. A study of the geology of this important coal basin of Southern France, showing the causes of some hitherto unexplained peculiarities. 3000 w. Comptes Rendus—Jan. 29, 1900. No. 32630 D.

Headframes.

Steel Headframes. Illustrated description of recent examples erected in the Wyoming and Lackawanna coal basins of Pennsylvania. 3500 w. Mines & Min—Feb., 1900. No. 32335 C.

Indian Coal.

The Coking Quality of Indian Coal. From a report by R. H. Mahon on experiments made to test the coking quality. 4500 w. Col Guard—Feb. 2, 1900. No. 32474 A.

Pillars.

Pillar Drawing. Jas. B. Davis. Illustrated description of the method used for taking out pillars when the workings have been flushed with culm. 1000 w. Mines & Min—Feb., 1900. No. 32333 C.

Report.

The Report of the Rhenish Westphalian Coal Syndicate for the Year 1899 (Vorstandsbericht des Rheinisch-Westfälischen Kohlensyndikats über das Jahr 1899). Giving tabulated results of the year's operations, showing the increased output over the preceding year. 2000 w. Glückauf—Feb. 3, 1900. No. 32672 B.

West Virginia.

The Kelly's Creek Coal Mines, West Virginia. Edward H. Coxe. Describes the mine and manner of working. 1100 w. Eng & Min Jour—Feb. 10, 1900. No. 324[illegible]

Winding

Winding Drum with Tangential Arms at the Blanzy Colliery. Paul Perroy. From a communication to the Société de l'Industrie Minérale, Saint Etienne. Illustrated description of a new type of winding drum suggested by a bicycle wheel. 2700 w. Col Guard—Jan. 26, 1900. No. 32364 A.

COPPER.

Australia.

South Australian Copper Mines. Report of mines by the inspector, W. H. Matthews. 2500 w. Aust Min Stand—Jan. 11, 1900. No. 32499 B.

New Jersey.

The Schuyler Copper Mines, New Jersey. An illustrated account of one of the oldest copper mines in the United States. 1300 w. Eng & Min Jour—Feb. 3, 1900. No. 32347.

North Carolina.

The Union Copper Mines, Gold Hill, N. C. Dr. A. R. Ledoux. An account of this property, worked first for the gold, but long ago abandoned; recently reopened. Its fine plant is illustrated and described. The ores carry gold and silver in small quantities with the copper. 3300 w. Eng & Min Jour—Feb. 10, 1900. No. 32439.

Review.

The Copper Market and Copper Mining Finance in 1899. John B. C. Kershaw. A review of the year and the causes of anxiety to those interested in copper production. 1500 w. Elec Rev, Lond—Feb. 2, 1900. No. 32457 A.

Supply.

The World's Supply of Copper. Frederick H. Hatch. A very comprehensive review of the output and consumption, with numerous tables and statistics, and illustrated descriptions of important mines and smelting works. 5000 w. Engineering Magazine—March, 1900. No. No. 32685 B.

United States.

Copper Resources of the United States. Henderson Gilbert. A review of the mines and their output. 1600 w. Yale Sci M—Feb., 1900. No. 32391 C.

GOLD AND SILVER.

Amalgamation.

Note on the Plate-Amalgamation of Gold and Silver. E. A. H. Tays. Data regarding plates from four battery-aprons. 500 w. Trans Am Inst of Min Engs—Feb., 1900. No. 32544 D.

Aurex Sluice.

Notes on the Aurex Sluice. T. M. Chatard and Cabell Whitehead. Describes this apparatus for utilizing the electric current in connection with cyanide solutions upon gold and its ores, giving the results obtained in test-runs, and the conclusions reached. 3400 w. Eng & Min Jour—Feb. 3, 1900. No. 32348.

Black Hills.

Gold Ores of the Black Hills, South Dakota. H. M. Chance. Describes the silicious gold-belt, the reduction works, and gives an account of the principal Black Hills gold-mining companies. 3000 w. Trans Am Inst of Min Engs—Feb., 1900. No. 32552 D.

British Columbia.

The Auriferous Alluvium of the Fraser River and Its Tributaries. J. D. Kendall. Part first gives an outline of the economic history and some hydrographic data. 2000 w. B. C. Min Rec—Feb., 1900. Serial. 1st part. No. 32484 C.

California.

Gold Bearing Lodes of the Sierra Costa Mountains in California. O. H. Hershey. Describes the general geology of this region and the mining districts, discussing the probability of the deposits proving valuable. 7700 w. Am Geol—Feb., 1900. No. 32490 D.

Cape Nome.

The New Mining District at Cape Nome. Enos Brown. Information concerning this region, its location, climate, deposits, etc. 900 w. Sci Am—Feb. 3, 1900. No. 32265.

Chlorination.

The Chlorination of Gold-Ores. F. C. Smith. Gives briefly the history and chemistry of the process, its operation and the difficulties. 3300 w. N. Z. Mines Rec—Nov. 16, 1899. No. 32259 B.

Cœur d'Alene.

Cœur d'Alene Mining Region. Arthur Lakes. Illustrates and describes the peculiarities of the country and gives an account of some of the larger mines. 2000 w. Mines and Min—Feb., 1900. No. 32-339 C.

Crushers.

The Bryan Mill as a Crusher and Amalgamator as Compared with the Stamp-Battery. E. A. H. Tays. Experience of the writer with the "Bryan roller quartz mill." 1800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 32-546 D.

Distribution.

The Occurrence of Gold. W. H. Storms. Shows the wide distribution of gold and the need of careful study even where indications are absent. 1200 w. Min & Sci Pr—Feb. 10, 1900. No. 32502.

Dredging.

Dredging for Gold. Theo. F. Van Wagenen. Considers the problem of gold recovery by dredging, the conditions, etc. Ill. 2000 w. Min & Sci Pr—Jan. 27, 1900. Serial, 1st part. No. 32261.

Dredging: Its Present and Future Outlook. J. G. Hyde. On the chief difficulties yet to be overcome in gold-dredging.

1000 w. N. Z. Mines Rec—Nov. 16, 1899. No. 32256 B.

The Waiau River as a Gold-Dredging Channel. Ro. Carrick. A description of the dredging-ground. 1500 w. N Z Mines Rec—Nov. 16, 1899. No. 32257 B.

Georgia.

Gold Mining and Milling in Georgia. H. V. Croll. A brief illustrated description of past methods and remarks on recent advances. 2000 w. Min & Sci Pr—Feb. 3, 1900. No. 32402.

Gold Mine.

How to Open Up a Gold Mine. S. A. Josephi. Considers the necessary work, how it should be done, and particulars in regard to the probable cost. 1400 w. Mines & Min—Feb., 1900. No. 32334 C.

Kootenay.

In the Kootenay, B. C., District. Notes on Rossland Camp, Nelson, Slocan and Boundary districts. 2000 w. Can Min Rev—Jan. 31, 1900. No. 32297 B.

Mexico.

The Gold Zone of Copalquin, Durango, Mexico. Frank B. Fowler. An illustrated account of the San Fernando mines is given in part first. 2100 w. Eng & Min Jour—Feb. 24, 1900. Serial. 1st part. No. 32723.

Nova Scotia.

What Has Become of the Gold Run in the Tailings? B. C. Wilson. Read before the Min. Soc. of Nova Scotia. On the doubtful value of old tailings. 1300 w. Can Min Rev—Jan. 31, 1900. No. 32298 B.

Quartz Mine.

The O. P. Q. Quartz Mine, Waipori, Otago. An account of its development, with description of the working plant. 1300 w. N Z Mines Rec—Nov. 16, 1899. No. 32258 B.

Rhodesia.

Gold Mining Prospects in Rhodesia. R. R. Mabson. A very complete account of the ancient workings, existing mines and conditions of present production, with many characteristic illustrations. 4000 w. Engineering Magazine—March, 1900. No. 32680 B.

Silver King.

Geological Elements of the Silver King Basin. W. H. Lampker. Describes an interesting geological formation of great economic importance in Arizona. 1700 w. Min Rept—Feb. 1, 1900. No. 32383.

Utah.

Silver-Bearing Sandstones of Southern Utah. Don Maguire. A description of one of the few localities where silver is found in a sandstone formation. 2700 w. Mines & Min—Feb., 1900. No. 32343 C.

IRON AND STEEL.

Basic Steel.

The Talbot Continuous Open Hearth Steel Process. Describes the plant at the Pencoyd Iron Works, the process, the operation, results, etc. 4000 w. Ir Age—Feb. 8, 1900. No. 32401.

The Talbot Steel Process at the Pencoyd Iron Works. Explains a continuous basic open-hearth process conducted in an 80-ton tilting furnace. 1000 w. Eng Rec—Feb. 17, 1900. No. 32526.

Bessemer.

Small Bessemer Plants for Steel Castings (Die Klein-Bessemerei für Stahlformguss und Temperguss). Carl Rott. A description of the use of small Bessemer converters, of less than 1000 pounds capacity, for use in making steel castings for general purposes. Details of operation are given, and the increasing use of such furnaces predicted. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 3, 1900. No. 32621 D.

British Columbia.

Discoveries of Bessemer Steel Ore and the Sources of the Placer Gold of the Fraser River. K. Ludloff. Letter to the editor giving an account of the discoveries made by the writer. 1600 w. B. C. Min Rec—Feb., 1900. No. 32485 C.

Cast Iron.

Cast Iron. W. R. Lethaby. Lecture before the Arch't Assn., London, with discussion. Suggestions as to the uses and treatment. 9000 w. Builder—Feb. 3, 1900. No. 32461 A.

Formation-Temperatures.

The Temperatures at Which Certain Ferrous and Calcic Silicates are Formed in Fusion, and the Effect upon These Temperatures of the Presence of Certain Metallic Oxides. H. O. Hofman. Describes investigations made to obtain accurate details on this subject. 8800 w. Trans Am Inst of Min Engs—Sept., 1899. No. 32549 D.

Iron Mining.

Readjustment of Iron Mining Costs. William Kelly. Synopsis of the presidential address before the Lake Superior Min. Inst. 3000 w. Ir Trade Rev—Feb. 15, 1900. No. 32501.

Japan.

The Japanese Imperial Steel Works. Emile Schrödter. Translated from *Stahl und Eisen*. An illustrated description of these works, and general remarks concerning the industry. 2500 w. Ir & Coal Trds Rev—Feb. 2, 1900. No. 32471 A.

Manufacture.

The Manufacture of Iron and Steel. William Kent. Reviews the history of iron manufacture, and traces some of the stages of development during the last two centuries. 3000 w. Sibley Jour of Engng—Feb., 1900. No. 32555 C.

Nickel Steel.

The Properties and Possible Uses of Nickel Steel. Editorial on the limited production of nickel and its impossibility of increase unless there is a discovery of nickel ore; with review of paper by David H. Browne, presented at the Inst. of Min. Engs.' meeting. 4000 w. Eng News—Feb. 15, 1900. No. 32518.

Pig-Iron.

A Peculiar Siliceous Efflorescence upon Pig Iron. B. F. Fackenthal, Jr. Descriptions and analyses of an efflorescence that appeared when the pigs were broken hot from the sow. 1500 w. Trans Am Inst of Min Engs—Feb., 1900. No. 32551 D.

Casting Pig Iron by Machinery. Illustrated description of machines built for the Cambria Steel Co., of Johnstown, Pa. 1000 w. Sci Am—Feb. 24, 1900. No. 32702.

Comments on Pig Iron Selling. George H. Hull. Read at Am. Foundrymen's Assn. Discusses the Syndicate System of Germany, the Warrant System of Great Britain, and selling methods in the United States. 4400 w. Am Mfr & Ir Wld—Feb. 8, 1900. No. 32440.

The Fracture of Pig Iron. Edward Kirk. Concerning some points of grading by this method. Considers the characteristics indicated as accurately as by chemical analysis, but only when judged by experts. 2000 w. Ir Trd Rev—Feb. 15, 1900. No. 32500.

Rail Steel.

Rail Steel—Its Chemistry and Heat Treatment. William R. Webster. A contribution to the problem of the relations between the chemical constitution and physical properties of steel. 3200 w. R R Gaz—Feb. 16, 1900. No. 32512.

Sampling.

A Device for Sampling Pig-Iron. Porter W. Shimer. Illustrated description. 400 w. Trans Am Inst of Min Engs—Feb., 1900. No. 32554 D.

Slags.

A Rapid Method of Determining Lime in Blast Furnace Slags. Titus Ulke. Describes a method recommended to smelter chemists, on account of the rapidity with which accurate lime determinations can be made by it. 300 w. Eng & Min Jour—Feb. 10, 1900. No. 32436.

Solution Theory.

Notes on the Solution Theory for Iron and Steel (Beiträge zur Lösungstheorie von Eisen und Stahl). Hanns Freiherr von Jüptner. A very full discussion by this eminent authority, of the theory of the solution of carbon in iron; with diagrams and curves, plotted from the researches of the author and of Eggertz and Howe. Four articles, 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 13, 20, 27, Feb. 3, 1900. No. 32673 each B.

Steel.

Our Steel Industry. Charles H. Cramp. The wonderful development and the relation to ship building. 4500 w. Marine Rev—Feb. 1, 1900. No. 32282.

Wire Mills.

American Wire Rod Rolling. Abstract of a paper by M. Baackes, read before the Verein Deutscher Eisenhuettenleute, on the Development of the Wire Rod Mill, with special reference to the United States. Ill. 4500 w. Ir Age—Feb. 15, 1900. No. 32488.

The Development of Wire Rolling Mills, with Especial Reference to the United States (Die Entwicklung des Drahtwalzwerkes mit Besonderer Berücksichtigung von Nordamerika). M. Baackes. A paper before the *Verein Deutscher Eisenhüttenleute* giving a very full description of the American wire-rod rolling mills, with discussion. 10,000 w. Stahl und Eisen—Jan. 15, 1900. No. 32639 D.

MINING.

Accounts.

Mine Accounts. A. J. Yungbluth. On the arrangement of mine accounts for the cost sheet. 5600 w. Can Min Rev—Jan. 31, 1900. No. 32299 B.

Bolivia.

Some of the Undeveloped Resources of Bolivia. Sir Martin Conway. Interesting description of the country and its products, containing information of the mineral wealth. Map, and discussion. 7000 w. Jour Soc of Arts—Feb. 2, 1900. No. 32455 A.

British Columbia.

Mineral Resources Around Kamloops. W. M. Brewer. Describes the topography and character of the country, and some of the mining properties. Gives illustrations of the Python mine. 1400 w. Eng & Min Jour—Feb. 10, 1900. No 32437.

Dam.

The Construction of a Concrete Dam in the 18 Heading of the Lillschächt Mine at Pribram (Ueber den Bau eines Betondammes am 18 Laufes des Lillschächter-Ostschlages in Pribram). W. Oppe. Describing the construction of an arched dam filled with concrete, to hold back the water in an important mine in Bohemia. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 20, 1900. No. 32674 B.

Disasters.

Notable Disasters in Foreign Mines (Bemerkenswerthe Unfälle beim Bergwerksbetriebe un Auslande). A tabulated list of mining disasters in other countries than Austria-Hungary, from 1895 to 1899 inclusive. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 27, 1900. No. 32675 B.

Explosion.

The Fire Damp Explosion at the Heinrich Shaft at Ostrawa, Moravia (Die Schlagwetter-Explosion am Heinrich Schachte in Mähr.-Ostrau). J. Mayer. A detailed account of the disaster, together with a description of the experiments made upon safety lamps. Serial. Part 1. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 3, 1900. No. 32676 B.

Explosives.

Blasting with High Explosives. Harold Bouser. Deals with the methods of igniting, the coal shots, choice of explosives, etc. Ill. 3400 w. Ir & Coal Trds Rev—Jan. 26, 1900. No. 32369 A.

Dynamite Magazines at Slight Depths. From a report by the French Explosive Substances Commission on the Blanzy experiments, published in the *Annales des Mines.* Describes the experiments, giving results and conclusions. Ill. 3700 w. Col Guard—Feb. 9, 1900. No. 32-582 A.

Methods of Priming and Firing Mine Shots. From a communication by Victor Watteyne and Lucien Denoël. Notes various solutions of the problem, but concludes that electric firing is the method most to be recommended. 1200 w. Col Guard—Jan. 26, 1900. No. 32368 A.

Haulage.

Endless Rope Haulage at the Coke Ovens of the Rochling Works. Herr Weihe. Translated from *Glückauf.* Illustrates and describes the arrangement of the haulage plane. 2200 w. Ir & Coal Trds Rev—Feb. 9, 19000. No. 32-571 A.

Hoisting Engines.

The Operation and Economy of Compound Hoisting Engines (Ueber Compound Fördermaschinen, deren Betriebs und Dampfkonsumverhältnisse). A general discussion of the applicability of compound engines for winding minehoists, giving data and results of tests of a number of engines in service. 4000 w. Glückauf—Jan. 27, 1900. No. 32671 B.

Mine Locomotives.

Benzine Locomotive for Mine Haulage. E. Braun, in the *Zeitschrift für das Berg Hutten und Salinen Wesen.* Illustrates and describes the engine of the Deutz Gas Engine Co., giving facts relating to its economy and power. 4000 w. Ir & Coal Trds Rev—Feb. 9, 1900. No. 32572 A.

The Use and Abuse of Colliery Locomotives. W. W. Clayton. Read before the Chesterfield and Midland Counties Soc. of Engs. A brief account of the first locomotive used in a colliery, in 1811, with suggestions concerning care and operation. 2800 w. Can Min Rev—Jan. 31, 1900. No. 32300 B.

Mine Surveying.

The Real Error of a Survey. Joseph Barrell. Notes on the accuracy of surveys in inclined seams and an analysis of the sources of error. 2500 w. Mines & Min—Feb., 1900. No. 32337 C.

Pumping Engines.

See Mechanical Engineering, Steam Engineering.

Safety Lamps.

Experiments with Safety Lamps. Bergrath Meyer, in *Oesterreischische Zeitschrift für Berg und Huttenwesen.* Investigations as to the cause of an explosion led to the interesting experiments described. 1000 w. Col Guard—Feb. 2, 1900. No. 32475 A.

Stoping.

Stoping with Machine Drills. B. L. Thane. An account of what was accomplished with a "Baby Ingersoll" drill in the Chief Mine, at Sundrum, Alaska. 2400 w. Trans Am Inst of Min Engs—Sept,. 1899. No. 32550 D.

Transvaal.

The Electric Power and Lighting Plant at the Transvaal Gold Mining Estates, Limited, at Pilgrim's Rest (Die Elektrische Kraft und Lichtanlage der Transvaal Gold Mining Estates, Limited, in Pilgrimsrest). F. Klonne. A fully illustrated account of this plant, one of the best among the Transvaal mines. 2000 w. 1 plate. Glückauf—Jan. 20, 1900. No. 32670 B.

MISCELLANY.

Address.

The Characteristics and Conditions of the Technical Progress of the Nineteenth Century. James Douglas. Presidential address reviewing the changes that have affected the industrial growth of the United States. 7300 w. Trans Am Inst of Min Engs—Sept., 1899. No. 32553 D.

Aluminum.

The Latent Heat of Aluminum. E. Grafstrom. Brief illustrated account of experiments made by the writer. 600 w. R R Gaz—Feb. 23, 1900. No. 32705.

Brass.

See Mechanical Engineering, Machine Works.

Exposition.

The Industrial and Trade Exposition at Düsseldorf in 1902 (Die Industrie und Gewerbe Ausstellung in Düsseldorf in Jahre 1902). A short announcement concerning this forthcoming exposition, with especial relation to the department of mining and metallurgy, giving a view of the proposed mining building. 1500 w. 1 plate. Glückauf—Jan. 20, 1900. No. 32669 B.

Manganese.

The Manganese Deposits of Bahia and Minas, Brazil. John C. Branner. An account of these deposits, and illustrated description of the mines and method of ore cleaning. 3500 w. Trans Am Inst of Min Engs—Sept., 1899. No. 32548 D.

Metallography.

A View of the Present Status of Metallography (Ueberblick über den Gegenwärtigen Stand der Metallographie). E. Heyn. A discussion of the microscopic study of etched sections of metals and alloys, showing the progress which has been made in the study of materials by this method. Serial. Part 1. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Feb. 3, 1900. No. 32620 D.

Petroleum.

Petroleum in California. W. L. Watts. Address delivered at Los Angeles, Cal. Reviews the history of this mineral product in the state, describing the oil-fields. 2400 w. Trans Am Inst of Min Engs—Oct. 1899. No. 32545 D.

Petroleum in Europe (Le Pétrole en Europe). H. Neuberger and H. Noalhat. With especial reference to the wells in Central Galicia, in which American methods of working have been introduced. 4000 w. Revue Technique—Jan. 10, 1900. No. 32606 D.

The Development of the Petroleum Industry in the Caucasus (Développement des Enterprises de Pétrole au Caucase). A review of the commercial side of the subject, with data about the various companies engaged in the industry. 1800 w. Moniteur Industriel—Feb. 3, 1900. No. 32677 E.

Zinc and Lead.

Zinc and Lead Mines of Missouri and Kansas. Horace J. Stevens. An account of these mines, their production and future prospects. 2600 w. Mines & Min—Feb., 1900. No. 32340 C.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Rolling Stock in the United States. From advance sheets of the report of the Interstate Commerce Commission reviewing the causes of accidents to employees. 1400 w. R R Car Jour—Feb., 1900. No. 32433.

Train Accidents in the United States in December. Detailed list and classified summary. 5000 w. R R Gaz—Feb. 2, 1900. No. 32295.

Train Accidents in 1899. Editorial review with tables of statistics. 1500 w. R R Gaz—Feb. 23, 1900. No. 32706.

Car Movements.

The Graphic Block System of Recording Car Movements. Illustrated description of the system developed by G. H. McNamara for keeping a record of the movements and location of freight cars. It consists in using a separate card for each car, the cards being arranged in special filing cases. 2000 w. Eng News—Feb. 8, 1900. No. 32407.

Employees.

The Systematic Selection of Employees. R. C. Richards. Considers the importance of having good employees, and suggests a plan. 1400 w. Ry Age—Feb. 23, 1900. No. 32730.

Haulage.

Waste Haulage. Editorial giving an account of locomotive performance on the Soudan & South-Western Ry., and discussing economy in haulage. 2000 w. Engr, Lond—Feb. 2, 1900. No. 32468 A.

Prussia.

The Condition of the Royal Prussian Railway System for the Year 1900 (Die Etat der Königlich Preussischen Eisenbahnverwaltung für das Etatsjahr 1900). A statement of the official administration of the system, with details of expenditures for operation, maintenance, etc. 5000 w. Stahl und Eisen—Feb. 1, 1900. No. 32641 D.

Transportation.

Our Railroads and Our Canals. George H. Daniels. Extracts from an address delivered before the Utica Chamber of Commerce. 1700 w. Ry & Engng Rev—Feb. 24, 1900. No. 32741.

Transportation Department of Railroads. Russell Harding. Describes the tonnage system in train service, and notes its benefits. 1700 w. Ry Age—Feb. 23, 1900. No. 32731.

MOTIVE POWER AND EQUIPMENT.

Bolsters.

Bolster Specifications and Tests. Some considerations in regard to the design of bolsters, and suggestions for testing. 900 w. Am Engr & R R Jour—Feb., 1900. No. 32268 C.

Box Cars.

Report of Committee on Typical Dimensions of Standard Box Cars. Ill. 3500 w. Cent Ry Club—Jan., 1900. No. 32735 C.

Brake Recorder.

An Automatic Recorder of Emergency Brake Applications. Illustrates and describes the invention of W. E. Symons, which is intended to register all emergency applications of the brake, but does not record service applications. 450 w. R R Gaz—Feb. 2, 1900. No. 32294.

Car Heating.

Car Heating in Germany, Austria and Switzerland. Illustrated description of the systems used. 2600 w. R R Car Jour—Feb., 1900. No. 32435.

Car Ventilation.

Ventilating Passenger Cars on the Pennsylvania. Illustrated description of the system used. 600 w. R R Gaz—Feb. 9, 1900. No. 32452.

Couplings.

Accidents to Railway Servants. Editorial discussion of the report of the Railway Couplings Commission. 2000 w. Engr, Lond—Jan. 26, 1900. No. 32-374 A.

Report of the Railway Couplings Commission. Extracts from the report concerning accidents, the value of automatic couplings, etc. 4200 w. Col Guard—Jan. 26, 1900. No. 32367 A.

Draft Appliances.

Exhaust and Draft. Arrangements in Locomotives. Synopsis of review of the progress of the past ten years, made by C. H. Quereau. 900 w. Am Engr & R R Jour—Feb., 1900. No. 32276 C.

Driver Brakes.

Improvements in Locomotive Driver Brakes. Illustrates the driving-wheel brake-rigging on the new locomotives built for the Lake Shore & Mich. So. Ry. and discusses present practice. 1400 w. Am Engr & R R Jour—Feb., 1900. No. 32274 C.

Driving Wheels.

Cast Steel Driving Wheels. Illustrations of various designs and information concerning them. Am Engr & R R Jour—Feb., 1900. No. 32272 C.

Grates.

Grates for Coke Burning. Information from J. S. Turner concerning coke burning on locomotives. Ill. 900 w. Am Engr & R R Jour—Feb., 1900. No. 32271 C.

Journal Boxes.

Instruction in Care of Journal Boxes. Describes a model used in instructing the men on the New York Central & Hudson River R. R. 1200 w. Am Engr & R R Jour—Feb., 1900. No. 32277 C.

The Proper Care of Packing in Journal Boxes, and Its Important Relation to Successful Lubrication. Discussion of the subject by H. C. McCarty and others. Ill. 11200 w. Cent Ry Club—Jan., 1900. No. 32734 C.

Locomotives.

Compound Locomotive for the Western Railway of France. Illustrated description of this new type for a railway leading to Paris. 700 w. Engng—Feb. 2, 1900. No. 32462 A.

Consolidation Freight Locomotives. Illustrated description of one of twenty-five freight locomotives, recently completed for the Lake Shore & Mich. So. Ry. 800 w. Am Engr & R R Jour—Feb., 1900. No. 32269 C.

Cooke Consolidation Locomotive, L. & N. Ry. Illustrated description with dimensions. 900 w. Ry & Engng Rev—Feb. 3, 1900. No. 32389.

Express Passenger Engine, North-Eastern Railway. Illustration and dimensions. 700 w. Engr, Lond—Feb. 2, 1900. No. 32467 A.

Locomotives on Egyptian Railways. Information from the report of F. H. Trevithick concerning the American and English locomotives. 2000 w. Ind & Ir—Jan. 26, 1900. No. 32363 A.

Marine Boiler Locomotive, A., T. & S. F. Ry. Illustrates and describes the application of a Scotch marine boiler to a locomotive. The engine is on trial in switching service in the Topeka, Kan., yards. 1400 w. Ry & Engng Rev—Feb. 10, 1900. No. 32487.

The Adaptation of the Locomotive for Safe High Speed Travel, with Special Reference to the Proper Method of Balancing its Reciprocating Parts. William E. Lockwood. On the effects produced by counter-balancing the driving wheels. Also discussion. 4200 w. N. Y. R R Club—Dec. 21, 1899. No. 32255.

The Detailed Weights of a Locomotive Engine. Gives list of the actual weight of the various parts of a goods engine and tender, V 14 class. 1800 w. Engr, Lond—Feb. 9, 1900. No. 32575 A.

The Four-Cylinder Compound Locomotives of the Northern Railway of France. Illustrated description of the engines designed for special service on this road. 2200 w. Sci Am—Feb. 17, 1900. No. 32505.

The Locomotive—Recent Practice and

the Future. F. W. Dean. Extracts from a paper read before the New England Railroad Club. Review and critical discussion of features of recent design. 3200 w. R R Gaz—Feb. 16, 1900. No. 32513.

Twelve-Wheel Compound Chicago & Eastern Illinois Railroad. Illustration and description of the latest heavy freight locomotive of the named road. 600 w. R R Gaz—Feb. 23, 1900. No. 32704.

See Street and Electric Tramways.

Lubrication.

Lubrication. A topical discussion by H. B. Hodges, Gen. Charles Miller, A. M. Waitt, and many others. 1700 w. N. Y. R R Club—Jan. 18, 1900. No. 32738.

Milk Cars.

New Milk Cars, Lehigh Valley Ry. Illustrated description of improved refrigerator milk cars. 500 w. Ry & Engng Rev—Feb. 17, 1900. No. 32558.

Mine Locomotives.

See Mining and Metallurgy, Mining.

Pintsch Gas.

See Gas Engineering.

Staybolts.

Staybolt Progress. Willis C. Squire. A letter discussing the movement of the side sheets and firebox sheets relative to one another, due to differences of temperature, and suggesting a line of investigation. Ill. 1200 w. Am Engr & R R Jour—Feb., 1900. No. 32275 C.

Tenders.

Locomotive Tenders. William Forsyth. A discussion of the tenders on English and American locomotives, and the improvements made in modern American designs. 2200 w. Am Engr & R R Jour—Feb., 1900. No. 32273 C.

NEW PROJECTS.

Africa.

The Railways of Africa (Die Eisenbahnen in Afrika). H. Claus. An excellent review of existing and proposed railways, classified according to political conditions, accompanied by a very good map. 3500 w. Glaser's Annalen—Jan. 15, 1900. No. 32643 D.

India.

Indian Railway Prospects. Notes the new schemes under the several railway systems, with histories of some of the more important. 8500 w. Ind & East Engr—Jan., 1900. Serial. 1st part. No. 32508 D.

PERMANENT WAY AND FIXTURES.

Compressed Air.

The Use of Compressed Air in the Freight Yard of the Lake Shore and Michigan Southern Ry. at West Seneca, N. Y. Illustrated description of this plant, and the uses to which it is applied. 3300 w. R R Car Jour—Feb., 1900. No. 32434.

Fastenings.

The Consolidation of Fastenings in Railway Cross Ties (La Consolidation des Attaches dans les Traverses de Chemims de Fer). M. Cartaull. A description of the Collet system, in which a trenail is screwed into a hole tapped into the cross-tie, the rail bolt then being screwed into the trenail. Used on the Paris, Lyons, and Mediterranean Railway. 2500 w. Rev Gen de Chemins de Fer—Feb., 1900. No. 32647 F.

Grades.

The Theory of Velocity Grades. Letters from Charles C. Wentworth, and C. Frank Allen, in further discussion of this subject. 2200 w. R R Gaz—Feb. 16, 1900. No. 32511.

Rails.

The Wear of Rails (Schienenverschleiss). K. Beyer. A discussion of a graphical method of determining the relative wear of rails of various sections. 1500 w. Scheweizerische Bauzeitung—Jan. 20, 1900. No. 32638 B.

Railway Shops.

Extension of the new Workshops of the Northern Railway of France (Agrandissements des Nouveaux Ateliers de la Compagnie des Chemin de Fer du Nord). A very full account of the locomotive works at Hellemes-Lille, with plans showing construction of buildings and arrangement of tools. Serial. Part I. 4 plates. 7000 w. Rev Gen de Chemins de Fer—Feb., 1900. No. 32648 F.

The Depew Shops of the New York Central. Illustrated description of some special devices in use and features of locomotive practice. 2000 w. R R Gaz —Feb. 16, 1900. No. 32514.

The Operation of the Hungarian Railway Workshops in 1897 (Erzebnisse des Werkstättendienstes der Königlich Ungarischen Staatsbahnen im Betriebsjahre, 1897). Rudolf Nagel. With tabulated statements of results, expenditures, and general details of operation. 4000 w. Glaser's Annalen—Feb. 1, 1900. No. 32645 D.

Signal.

The Lartigue and Forest "Crocodile" (Le "Crocodile" Lartigue & Forest). M. Cossmann. Describing the electric warning signal used on the Northern Railway of France. An electric contact of a brush on the locomotive with a shoe on the track operates a pneumatic whistle when a block signal is closed. 3500 w. Rev Gen de Chemins de Fer—Feb., 1900. No. 32646 F.

Station.

New Texas & Pacific Passenger Station at Ft. Worth, Tex. Illustrated description of this recently completed station. 600 w. Ry & Engng Rev—Feb. 3, 1900. No. 32390.

New Union Station at Dayton, O. Description, with illustrations, of a new union passenger station. 1100 w. R R Gaz—Feb. 23, 1900. No. 32707.

See Architectural Engineering, Heating and Ventilation.

Transcontinental.

American Transcontinental Lines. James Douglas. A sketch of the history, geography and topography of these railways. 15300 w. Trans Am Inst of Min Engs—Sept., 1899. No. 32543 D.

Transition Curves.

The Railroad Spiral. Editorial review of the condition of the transition curve problem, suggested by a paper by E. S. M. Lovelace. 1800 w. R R Gaz—Feb. 9, 1900. No. 32453.

STREET AND ELECTRIC TRAMWAYS

STREET AND ELECTRIC TRAMWAYS.

Bridge Crossings.

Trolley Wires Over Movable Bridges. Illustrated description of the arrangements on the North bridge at Hull, England. 600 w. Elec Eng, Lond—Feb. 9, 1900. No. 32591 A.

Cars.

Street Car Building. Charles Henry Davis. Illustrated detailed description of Stephenson practice. 800 w. St Ry Jour—Feb. 3, 1900. Serial. 1st part. No. 32330 D.

Claim Department.

The Organization of a Claim Department. J. W. Uppercu. Experiences and suggestions concerning this branch of street-railway service. 3000 w. St Ry Jour—Feb. 3, 1900. No. 32327 D.

Combination.

A Combination Steam and Electric Railway in Illinois. An illustrated account of the Peoria and Pekin Terminal Ry., which combines a street railway, an interurban electric railway and a steam railroad, all using the same tracks in common. 5200 w. St Ry Jour—Feb. 3, 1900. No. 32329 D.

Conduit Roads.

Electric Conduit Roads. Alton D. Adams. Briefly reviews surface-contact systems, third-rail, and electric conduit roads, explaining their operation and advantages and disadvantages. 2300 w. Munic Engng—Feb., 1900. No. 32-385 C.

Detroit, Mich.

New Equipment for the Rapid Railway of Detroit. Illustrated description of this improved line, which carries not only passengers, but freight and express matter, and also provides electric light and power in the cities, towns and residences on the route. 2500 w. St Ry Jour—Feb. 3, 1900. No. 32326 D.

Double-Current.

The Metropolitan Railway Company, Toronto, Ontario, and Its Double-Current System. Illustrates and describes the recent improvements and extensions. 1600 w. Am Elect'n—Feb., 1900. No. 32286.

Electric Traverser.

An Electric Traverser for Railway Carriages. M. Sabouret. From *Revue Général des Chemins de Fer.* Illustrates and describes interesting apparatus for carrying railway carriages from one line of metals across to adjoining rails, at the Orleans Railway Station at Paris. 500 w. Elec Eng, Lond—Feb. 9, 1900. No. 32592 A.

Electrolysis.

Cure of Electrolysis by Independent Returns. C. A. Newbaker. A discussion of the electrical conditions that cause dangerous electrolysis and the best means to favorably alter these conditions. 4000 w. Am Elect'n—Feb., 1900. No. 32287.

The Electrolysis Problem in Chicago. Edward B. Ellicott. Describes the conditions, giving illustrations, and discusses the cause of the troubles, and the remedy. 1800 w. W Elect'n—Feb. 10, 1900. No. 32454.

Elevated Railway.

Proposed Electrical Equipment of the Berlin Stadtbahn. From the *Elektrotechnische Zeitschrift.* Details of a proposal for the electrical equipment of the Berlin elevated railway, indorsing the multiple unit method. Also editorial. Ill. 9500 w. St Ry Jour—Feb. 3, 1900. No. 32-328 D.

Exposition.

Electric Transport at the Exposition of 1900 (Les Transports Electriques de l'Exposition de 1900). Emile Dieudonné. With a plan of the routes of the traveling platform, and the electric tramway, and plan and elevation of the trains for the latter. 1800 w. Revue Technique—Jan. 25, 1900. No. 32608 D.

Extension.

Recent Extension of the Bergen County Traction Company. Illustrated description of an extension containing a number of structural difficulties, and requiring trestles, viaducts and bridges. 1600 w. St Ry Jour—Feb. 3, 1900. No. 32325 D.

Goods Service.

Light Railway Goods. Service at Newburgh. An illustrated account of the methods employed by the Elec. Ry. Co. of Newburgh, N. Y. 1200 w. Tram & Ry Wld—Feb. 8, 1900. No. 32729 A.

Isle of Man.

A Water Power Tramway Plant in the Isle of Man. Illustrated description of a line 18 miles long worked solely by water power. 2000 w. Tram & Ry Wld —Feb. 8, 1900. No. 32728 A.

Isle of Man Electric Tramways: Water Power Utilization Plant. Illustrated description of the new turbine plant which has enabled the company to shut down their steam plant entirely and work their line solely by water power. 1200 w. Elect'n, Lond—Jan. 26, 1900. No. 32359 A.

Locomotive.

Modern Electric Locomotives (Moderne Elektrische Lokomotiven). A. Tischbein. A very comprehensive discussion of the present practice, including heavy locomotives, as well as those for shifting and local service, and for use in mining. Two articles, 7500 w. Glaser's Annalen—Jan. 15, Feb. 1, 1900. No. 32-642 each D.

Moscow.

The Electric Line of the First Street Railway Company of Moscow (Die Elektrischen Linien der Ersten Strassenbahn Gesellschaft in Moskau). Erich Krannhals. A general description of the plant, and views of points on the road and in the power house. 2000 w. Elektrotech Zeitschr—Feb. 8, 1900. No. 32659 B.

Motorman.

Some Notes on the Motorman as an Element in Street Railway Economy. Charles Hewitt. Reports experiments tried and the results. Also discussion. 1600 w. Pro Engs' Club of Phila—Feb., 1900. No. 32742 D.

Niagara Power.

The Application of Niagara Power to the Work of the International Traction Company. Sketches briefly the development of the generating plant and the transmission line, and gives detailed description of the machinery of the traction system. Ill. 3800 w. St Ry Jour—Feb. 3, 1900. No. 32323 D.

Philadelphia.

The Electrical Equipment of the Union Traction Company, Philadelphia. An account of some of the interesting features of the latest electrical practice, in the operation of the largest street railroad property in the world. Ill. 1700 w. Elec Rev, N. Y.—Feb. 7, 1900. No. 32394.

Power Plant.

See Electrical Engineering, Generating Stations.

Rail Welding.

See Electrical Engineering, Heating and Welding.

Rapid Transit.

An Important German Rapid Transit Problem. Concerning an experimental electric train built for the Wannseebahn. 1500 w. St Ry Jour—Feb. 3, 1900. No. 32331 D.

The New York Rapid Transit Tunnel. Illustrates the main features of construction in the proposed work, with map showing route, and gives an account of the undertaking. 1100 w. Sci Am—Feb. 3, 1900. No. 32266.

Single Rail.

The Single-Rail Suspended Railway Between Barmen, Elberfeld, and Vohwinkel (Die Einschienige Schwebebahn-Barmen-Elberfeld-Vohwinkel). A general description of this unique overhead electric railway, with an effective view of a portion of the completed work. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 27, 1900. No. 32619 D.

Snow Plow.

A Four-Motor Snow Plow. Joseph H. Smith. Illustrated description of a powerful plow built for the Interstate Consolidated St. Ry. Co., of North Attleborough, Mass. 1000 w. St Ry Rev—Feb. 15, 1900. No. 32509 C.

Toledo.

Toledo Traction Company. Burcham Harding. Illustrates and describes the plant of this company, which furnishes light and power on an extensive scale. 3800 w. St Ry Jour—Feb. 3, 1900. No. 32324 D.

Triest.

The Electric Plant of the City of Triest (Das Elektricitätswerk der Stadt Triest). G. Szuk. With plan and elevation of the building, and views in the engine and boiler rooms; also diagram of the switchboard, and map of the city, showing the primary and secondary distribution and the location of transformers. 2000 w. Elektrotech Zeitschr—Feb. 1, 1900. No. 32658 B.

Underground.

The Metropolitan Railway in Paris. Historical account and illustrated description of the construction. 4000 w. Engr, Lond—Jan. 26, 1900. No. 32372 A.

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LABOUR QUESTIONS IN ENGLAND AND AMERICA.

By Charles Buxton Going.

LESS than three years ago, Mr. J. Stephen Jeans concluded an article* in these pages with the following paragraph—remarkable, as current events have proved, for its prophetic quality:

"The most important and pressing problem presented for solution, so far as the United States are concerned, is whether the British situation or the American situation in relation to trade unionism is to be the industrial situation of the future. Neither country can stand still in view of the changing conditions presented by the great social upheaval that is going on all around. Labour is unquestionably more highly organised in Great Britain than in any other country. Is this not the inevitable result of Great Britain's priority of place as a manufacturing country? And, if it is due to that factor, is it not probable that in newer countries labour will acquire the same power and use it as remorselessly as it is now being used in leading British industries? If so, is it not probable that we are approaching a period when the troubles that have been faced and fought in Britain will engross the thoughts and efforts of American manufacturers? In other words, is the struggle between capital and labour being fought out in Britain once for all, or will it have to be gone over again, *mutatis mutandis*, in other industrial countries? Is the present British attitude of capital and labour the last word in this controversy, or may we look in the near future for conditions more nearly assimilated to those that prevail in the United States?"

Events follow fast in modern industrial life. The great British labour struggle, in the midst of which Mr. Jeans was writing, was ended

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* Lessons of the Great Engineering Strike in England. J. Stephen Jeans. The Engineering Magazine, Sept., 1897.

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about five months later by a treaty under which England's mechanical trades have enjoyed a prosperity beyond all precedent, and under which also the relations of employer and employee are maintained with a smoothness, a freedom from break, or even severe strain, and a confidence of stability above anything heretofore known. Two years more and the field of battle, or of threat of battle, is shifted to the United States. It seems doubtful now if the issue will really be joined at this time. Both sides seem willing to temporise—the men, perhaps, because not sure enough of their position—the manufacturers, because they believe that a better time can be found for making a final stand. But at some time and in some way the case must be tried on its merits before the court of public opinion, decided by the inevitable rulings of industrial laws, or "settled out of court" by the now contending parties through the exercise of sober reason, in the light of the clear facts and changeless logic of industrial evolution. And as evolution becomes apparent by reading back in the life history of a type, or by studying the successive stages of progress in kindred forms, the recent history of English labour conditions is of the highest interest at present. For the American manufacturer, it points surely to the way in which affairs in his own country are tending; to the British engineer employer, it indicates the future of one of Britain's greatest competitors and stimulators in engineering work.

There is a curious likeness between the seeming and the real issues in the two countries. In each, the demand which the men put most conspicuously forward—the one of which press and public have heard most—is that for reduction of the length of the working day. This portion of the demand of the English trade unions is thus summarised by Mr. Jeans in the article already referred to:

"The workmen, in making the present demand, claim that a reduction in the hours of labour is required, in order to give the workmen more time for study and recreation; that the proposed system would enable the workman to start work in the morning with his breakfast, and consequently in a fitter condition for actual labour; and that the effect of reducing the hours would be to provide more employment, and consequently to reduce the number of artisans out of work. Another claim has been made, strangely inconsistent with the one last-named—namely, that under the improved social conditions assumed, the average workman can do as much work in eight hours as in nine.

"On the other hand, the employers refuse to admit that the claims of the workmen are reasonable, or their reasoning accurate. They argue that the reduction in the hours of labour would mean an increase of 5 to 10 per cent. in the cost of production, which would be disastrous in face of the severe foreign competition now prevailing; that already they have the utmost difficulty in securing orders against continental countries and the United States; that, as all machinery in well-regulated shops is already worked to its utmost capacity, it would be impossible to make up for lost time; that, apart from this controlling aspect of machinery, their experience of the nine-hour-day change did not show that workmen were ready or competent, as a general thing, to do as much work in a shorter period as in a longer period; that establishment charges could not be reduced in proportion to the reduction in hours; that the change would increase, *pro rata,* the maintenance of machinery; and that, if the eight-hour day is to be adopted, it should be accompanied either by a reduced rate of wages, *or by the removal of the restrictions at present imposed by the workmen's unions, in reference to piece-work, apprentices, over-time, the working of machine-tools, and other matters."*

The concluding words are italicised in quotation, because in them lies the suggestion of the real issue which was at stake in the English, and now is in the American, labour situation. If the reduction of the hours of labour had indeed been the sole question, it is doubtful if the employers would have made any very uncompromising stand, or would have received any very strong support from public opinion had they done so. It is, indeed, noteworthy and confirmatory of the position assumed above—that England is a prototype of the United States in the evolution of labour conditions—to observe that as long ago as 1870 there was adopted, in British mechanical works, the nine-hour day for which American machinists are now agitating.

There are, of course, many things to be most carefully considered and adjusted before any such change can go into effect. Unfilled contracts, or established prices for product, are the most obvious; the longer hours of idleness for expensive plant can by no means be ignored. But with proper compensation in the *manner* of working, there is little question that the *hours* of working might be materially reduced without loss of wage earnings to the workman nor increase of cost of product to the employer. Actual practice under the piece-work system has proved this too often and too definitely to leave much room for argument on the other side. In fact, the theorem that a man's labour-production is directly proportional to his hours of working, is almost as fallacious as the trade-union proposition that the amount of wage-winning work in the world is a definite quantity, and will be exhausted sooner by more diligent working.

The practice of many allied industries and the expressed opinion of not a few shop managers in the United States is in support of the nine-hour day. As one widely known American manufacturer said to me very recently, "the reduction from ten hours to nine seems to me as logical a step to-day as the reduction from twelve hours to ten was some time ago. I may be wrong—the time may not yet be ripe—but I think it is. I think before long we shall all admit that nine hours in the machine shop is a day's work." The movement, in all lines of industry, is toward larger output with less manual labour—more work from the tool, and less from the man. If the "machinery in well-regulated shops is already worked to its utmost capacity," the time has arrived for putting in more, or more efficient, machinery; but that it was *not* so worked in engineering workshops in England in 1897 is clearly indicated by the reference to the "restrictions * * imposed by workmen's unions in reference to piece work, apprentices, overtime, the working of machine tools, and other matters."

Herein lay the really important part of the matter. The demand for the eight-hour day in England, and less openly, perhaps, the strike for the nine-hour day in the United States, but served as a cloak for the actual body of the contention. The real substance of the issue, which united the employers of England—as it is certain to unite the employers of America—into a firmly-knit and finally-determined resistance, was the men's insistence upon the manufacturers' adoption of trade-union regulations in the operation of their works. However it was phrased, it meant in either case the delivery of the employers' business into the control of the men. To quote Mr. Jeans again:

"The present strike, however, is not merely a function of the demand for an eight-hour day. In a larger and wider sense, it is a practical protest of capital against the repeated and persistent attempts of the workmen to control the business of their employers. * * *

"One of these is the limitation of the number of apprentices. Another is the limitation in the number of machines which a workman can attend to—the union forbidding a man to work more than one machine, and in many cases more than one tool on each machine; while frequent attempts have been made to fix a minimum rate of wages.

"In American practice, as I am informed, there are no such restrictions on piece-work as in England, but each workman, acting on his own initiative, as a rule, makes his own individual arrangements."

The lapse of two years' time has brought about startling changes on both sides of the Atlantic—none more amazing, perhaps, than the American workman's willful abandonment of what Mr. Jeans called the "freer ideas and habits," which formerly were his, for the "demerits and disadvantages of the British system." It is but a short time since Mr. Hiram S. Maxim said:* "I do not believe that 1 per cent. of the highly skilled mechanics of the great workshops of New England belong to any sort of trade union. Trade unionism, if it exists at all, is confined to the unskilled labourers." And now the United States is menaced with a strike of the machinists, national in its extent and paralysing in its completeness. The whole country is to be "tied up," if necessary, to enforce the demand for—not merely the nine-hour day; that is a stalking horse—the "recognition" of the union by the employment of none but union men "in good standing"—that is, those who work under the union regulations in all things, including limitation of the number of apprentices; prohibition of piece work; refusal to run more than one machine, to work with non-union men, or to give any instruction to a handy man; dictation of minimum wages, and even limitation of product or of speed of working.

Those who read Mr. Norris' recent papers† will have gained some idea of the extent to which union domination has extended in the mechanical industries of the United States. There is no phase of the tyranny, of the stolid opposition to progress, of the blind adherence to false socialistic philosophy, of the cherishing of the "lump of labour" and other economic fallacies, of the determination to rule or ruin characterising British trade unionism, which does not appear in full vigour in the efforts and aims of the present labour unions of the United States.

The astounding and deplorable thing is that this line should be taken in the face of the certainty that the freedom and good sense formerly characteristic of the American working man have been the chief factors in bringing prosperity to him and to his country. He has been the most highly paid workman in the world because he was the most productive. And because their workmen were the most productive, the United States have won their way into the world's markets for machinery and machine tools. They have won it against competitors whose start was enormous, whose lead seemed to be too great ever to be closed up, but whose burden of conservatism and hobbles of labour restrictions held them back until the younger rival, late in the start but free and untrammeled in movement, had breasted and seemed ready to pass them. And now the chain and drag of trade-union making, which Britain has partially freed herself from after bitter and costly effort, the machinists of the United States are preparing to put on! Mr. Slater Lewis, elsewhere in this issue,* clearly indicates the satisfaction with which the competing trades of other countries would regard such a movement.

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* National Differences in Labour-Handling Methods. H. S. Maxim. The Engineering Magazine, Dec., 1897.

† Actual Experience with the Premium Plan. H. M. Norris. The Engineering Magazine, Jan., Feb., 1900.

There would be certain and permanent loss to the United States from an extended strike, even though the men—to their own enduring advantage—were to lose every point for which they seem disposed to contend. Beyond the immediate loss of wages to the men and of profitable orders to the employers, a certain, and perhaps considerable, amount of business would go elsewhere never to return. Trade, forced into new channels, is often loath to return to the old ones. America was a permanent gainer by the long protracted British engineering strike. She would be a permanent loser by similar troubles at home. Germany, as a competitor, is keener and more strenuous even than she was two years ago. England, awakened in every part, has been undergoing a reorganisation approaching almost to an industrial revolution. Expansion in the machinery trades, which was won with comparative ease by the United States when the conditions were peculiarly favorable to them, would be hard to hold when the conditions were adverse—harder still, if once it slipped away, to regain from competitors who now blend the best America's mechanical skill has devised with a commercial system she can as yet but faintly parallel.

But would a general strike of the machinists in the United States, forced along lines laid down in Chicago, end in victory for the men? Once more we may turn to England's great engineering strike for a forecast. The curves have been so far alike that we may be sure they have the same elements, and the path of the disturbance in the United States may be plotted by its forerunner in Great Britain. In February, 1898—nearly ten months after the opening skirmish—work was resumed in the engineering establishments of Great Britain under a general agreement between the Employers' Federation of Engineering Associations and the Amalgamated Society of Engineers—an agreement which can fitly be described as an utter rout of the men from every stand they had attempted to make. How complete was the emancipation of British industry from union tyranny, under this agreement, a few quotations will indicate.

"Every workman shall be free to belong to a trade union or not, as he may think fit.

"Every employer shall be free to employ any man, whether or not he belong to a trade union.

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* Works Management for Maximum Production. J. Slater Lewis. Page 213.

"Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the unions or any other body of workmen in their collective capacity arranging amongst themselves rates of wages at which they will accept work, but while admitting this position they decline to enforce a rule of any society, or an agreement between any society and its members.

"Employers are responsible for the work turned out by their machine-tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine-tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen.

"The right to work piece-work at present exercised by many of the Federated Employers shall be extended to all members of the Federation and to all their union workmen."

This was the outcome in a contest precipitated by a labour organisation immensely stronger, absolutely and relatively, than any in the United States, supported by a "war-chest" far richer than anything at the command of the International Association of Machinists. It was the outcome in a country where trade-union domination had, by long ineffectively-opposed exercise, attained a strength vastly greater and more pervasive than is the case in America.

Of course, against this in the final struggle was arrayed a federated strength of engineering employers correspondingly great; but this union of employers was forced by the conditions to be met, and the lesson has not been lost upon the American manufacturing world. The manufacturers won, however, not because they were strong but because they were right—because they were moving with, instead of vainly trying to oppose, the tremendous flow of industrial evolution Might and strife were needed to enforce the laws of progress, as military and police forces are needed to enforce the laws of civilisation; but the one, like the other, was not a creator of principles but merely an agent for carrying them out.

The whole story is another chapter in the history of the futile, because mistaken and misdirected, struggle against the introduction of the machine to emancipate the labourer. The first outcry was against the use of machinery at all; now it is against its employment to its fullest possibilities. The old fallacy, that the superseded workman must starve, is given a new dress and put to a slightly altered task, as futile as the first has been shown to be by the clear light of events. Machinery, in replacing hand work, has not only increased creature comforts and raised the general standard of living to a level undreamed of in advance, but in addition has widened the field for labour to an even greater degree, furnishing profitable work for hundreds where one could find employment before, and bringing up with it to a corresponding plane the functions and the intelligence of the worker. Sooner or later, it must become apparent to all that the use of machinery to its utmost capacity is only a second step in the same movement, destined to be equally beneficent in its results. And in this phase of the evolution the machine shop is the principal field, and the machine tool the chief embodied exponent.

Groundless fears are entertained, by many, of the effect upon the operative of specialisation and the introduction of automatic machinery. It can have but one result: the raising of the former partly-skilled attendant to the grade of a far more highly-skilled tool-maker and designer; the creation, from "common labour," of a new order of skilled tool-operatives; and the opening to both of wider possibilities for mental freedom and growth and the cultivation of the broader interests of humanity.

Perhaps the greatest and most lastingly useful lesson of the British engineering strike is the value of federation, when wisely directed and righteous in purpose. Trade unionism served good and much needed ends in opposing abuses of the employers' power. It has many excellent purposes still to be carried out. But in its unwisdom, it has undertaken measures in which it can be checked and corrected only by such an association of employers as shall not only be just and beneficent in its aims, but strong enough to make them effective.

Such an organisation, it seems to be conceded, has been inaugurated in Great Britain. Of the needs and opportunities for the institution of its counterpart in the United States Mr. Hoyt, one of the ablest exponents of the movement, writes in the following article. Should the strike of the International Association of Machinists not spread to the threatened proportions, it will afford only a happier opportunity for developing, steadily but dispassionately, the growth of a manufacturers' federation which will go a long way toward making a future "labour war" impossible—because it will reveal itself as the truest friend and most helpful aid to men, as well as to employers.

MANUFACTURERS' ASSOCIATIONS, LABOR ORGANIZATIONS, AND ARBITRATION.

By H. W. Hoyt.

IN an address before an association of manufacturers recently, a practical economist, who is himself an extensive manufacturer, made the following significant statement when speaking of the beneficent results flowing from the national arbitration of labor disputes in his line of business:

"The result of all this is that we have had absolute peace in our business. In the management of our business during these thirteen years I do not think we have ever given a single day to the consideration of labor questions, and never have been compelled to publish on our letter-head that 'All agreements are subject to strikes and other occurrences beyond our control.'"

So happy a condition of one very large manufacturing industry is chiefly the result of intelligent co-operation among manufacturers whose plants are widely scattered over the United States and whose employees are to a large extent members of an aggressive union. In this instance the union was a fixed fact long years before the manufacturers had considered the utility of co-operation. The relation of employer and employee had become so strained in that trade that financial ruin was imminent. Strikes, often of great violence, were occurring several times annually. Conditions became unbearable, as well to the employee who was a continual loser by his acts of depredation as to the employer who was steadily drifting on the rocks.

In desperation, seeing the inevitable failure of separate endeavor and isolation, a few manufacturers met and laid the foundation of an organization that has now the pleasure and profit of reflecting upon the peaceful and prosperous picture faithfully portrayed by its most distinguished member in the words above quoted. The significant feature of this particular case is the fact that the employee is as well satisfied as the employer.

It is of particular interest to compare Mr. Hoyt's convincing and practical argument for federation of employers in the United States, with Mr. Slater Lewis' clear summary of the benefits already secured by such an association in Great Britain. Mr. Lewis' article will be found on page 211 of this issue. THE ENGINEERING MAGAZINE is fortunate in bringing together two so able advocates in a cause of great current interest.—THE EDITORS

Self interest is the powerful incentive that is first invoked to urge manufacturers into alliances for mutual protection. If this, however, were the only reason for co-operation, it is doubtful whether the far-seeing economist would approve of such an organization. If the National Founders' Association, one of the most powerful of manufacturing organizations, were simply a fighting machine with its guns trained on labor unions, its claims of usefulness would be challenged by every right-thinking man. If the same association were a trade trust whose object was to purchase the services of its employees at the greatest possible bargain, and in turn to dispose of its product at prices induced by some controvention of the natural laws of trade, it would be open to the strongest censure.

Without desiring to direct attention to any particular association, but with the sole object of presenting a type of the greatest interest, it is pertinent in this connection to give the following extract from the constitution of the National Founders' Association:

ARTICLE II.

SECTION I. The objects of this Association are: First, the adoption of a uniform basis for just and equitable dealings between the members and their employees, whereby the interests of both will be properly protected; second, the investigation and adjustment by the proper officers of the Association, of any question arising between members and their employees.

It will probably be conceded that this "object" is pacificatory —in fact, that it exhales the very spirit of peace and good will.

The organization founded upon this basis is intensely practical. During the past year its good offices have been invoked scores of times to relieve strained conditions, and success has been achieved in nearly every instance. Not only has it been able, through the co-operation of its employees, to prevent strikes and lock-outs, but the association has entered the field of arbitration upon a plane seldom attained by anyone except theorists. It has not only shown wisdom in dealing with the concrete relations of employer and employee, but has begun with great zeal to investigate some of the fundamental questions of social economics in their bearing upon the always complicated relations of employer and employee. In the consideration of these subjects and their practical application, the manufacturers have invited and secured the hearty co-operation of one of the most powerful trade unions now to be found among American organized labor.

The association of manufacturers cited has at least two prototypes whose constitutions are practically identical. Broad as these constitutions are, the actual work of these associations is still broader. They have discovered common ground upon which the employer and employee may safely meet. They have eliminated, to a large degree, the common distrust and the consequent violent contentions. Partial failures to avert industrial wars have been so rare as to invite the hope of ultimate complete success

If it is possible for one branch of industry to achieve emancipation from the exhausting industrial wars, the irresistible inference is that it is equally possible for all trades to do likewise. Many other conclusions are obvious, one of which is that it is a solemn duty laid upon the employers of labor jointly to promote, by organized effort, the mutual loyalty and prosperity of employer and employee. From their vantage ground, the employers should make the first advances. With honest endeavor and with clean hands they should take up the economic questions and invite co-operation from both organized and unorganized labor. They should not allow themselves to become cynical when forced to join issue with the worst phases of unionism. Let them first examine their own position and see if it is founded on justice. Satisfied upon this point, let them bring the whole influence of their financial strength against the encroachments of a tyranny that, however it may oppress capital, is infinitely more blasting in its effects upon labor. Labor organizations have a mission that is justified in every rational mind; but in unwise hands the power of labor organizations often becomes a grievous menace. The members of labor unions sometimes find that they have placed shackles upon their own wrists that they are powerless to cast off. Against such slavery —against the proposition that honest men and good mechanics may be arbitrarily deprived of their rights and driven into helpless poverty—it is the duty of the manufacturers to stand like a stone wall. It is equally their duty to inculcate within their own ranks a spirit of equity that will lead to absolute justice in their relations with their employees.

In reviewing the work of a manufacturers' convention recently held, an impartial critic said:

"Evidently a deep sense of the great responsibility resting upon their shoulders was felt by the employers present in that assemblage, many of whom exercise authority in that capacity over hundreds of men. It was, therefore, with no light or trifling manner that they decided questions of policy or principles which were brought before them for determination. Without losing sight of the fact that they might at any time be forced to take stern measures to preserve their own rights and perhaps their own business existence, they showed that they were animated by higher motives than the endeavor to get the largest possible profit from the employment of other men. If all defensive organizations can be established and conducted upon the same high plane, the irrepressible conflict between capital and labor will be shorn of much of its unpleasantness.

To reduce the friction which has seemed hitherto unavoidable between the manager's office and the workshop, is a consummation most devoutly to be wished. To eliminate the local business agent and his petty tyranny, and to substitute national agreements between the chief executive officers of employers' and labor organizations, is an enlightened step. It is a movement promising the greatest possible good to both parties. From the broader view of a national standpoint, the perspective is very different from that appearing to the vision limited to the office or shop. Both sides look out on a wider horizon and get a clearer perception of principles. Removed from the local environment men's ideas clear up and trivial contentions are forgotten. The new conditions beget a kindlier feeling and a mutual forbearance.

Nor is this all. The manufacturers' associations have been singularly educative. They have certainly broadened the members' views and made them more tolerant of one another. Without in any degree cultivating the slightest tendency toward trusts, as the term is commonly and correctly understood, these associations have led to serious inquiries into shop practices and to the almost total extinction of every undesirable condition. They have, in a large degree, brought about a uniformity of action along well considered lines and elevated the tone of the whole industry.

The labor unions have shown manufacturers the necessity of combining for protection, and some, at least, of the manufacturers associations have shown the way to peace, without employing drastic measures and without dishonor to either side.

RAILWAY OPPORTUNITIES IN THE ORIENT.

By Wm. Barclay Parsons.

THE future of railway development in China and the promise it may hold for engineering interests in Europe and America may, perhaps, best be studied by considering what China's neighbors have done. On one side we have India and on the other Japan. While the Hindoos and Japanese are races different from each other and from the Chinese, the differences are not so great as to destroy the usefulness of the comparison. They are all Orientals, with many institutions—and even religion in part—in common; their countries have a dense population, while they themselves possess a natural disinclination to change established ways, a strong and almost bigoted desire for hand-labor methods, and a tendency towards a suspicion of foreign ways.

KHOJAK TUNNEL, SIND-PESHIN RAILWAY, INDIA.
Showing station building and passenger train.

The Indian system of railways is of many years' growth, and has now attained a length of 25,000 miles. It may be urged that this gets its strength, and therefore has reached its development, through British, and not native, sources, and consequently is not a fair parallel.

for other eastern nations. It is, of course, true that the original incentive and the power of promotion is foreign; but it is equally true that, unless the great mass of people will patronize the newer systems of transportation—no matter how energetically they may be promoted and extolled—they will not pay, and if the first lines do not pay no subsequent ones will be built. The Indian system does pay, in spite of very heavy cost in construction, and pays from the receipts from those classes who usually are not supposed to have the means at hand. The receipts of the whole Indian system amount to $4,000 gold per mile, while the receipts of the "standard-gauge" portion are more than $5,000 per mile, with the chief lines showing results as high as $11,000 gold; and these figures are obtained in a country where the natives are poor as any to be found on the Asiatic continent, and where a heavy mineral traffic, such as that in coal, is not obtainable, as it is in the more favored Oriental countries.

The Japanese railway system, however, is quite free from the objection that may be brought against the Indian railways as standards of comparison, because here we have all Oriental conditions without foreign pressure, except as foreign engineers or others may have been retained from time to time for advice; and, therefore, in the Japanese system we find an example by which we can judge of the possibilities of development, as to the Oriental's capability not only to adapt himself to new conditions, but to take up the construction and manage-

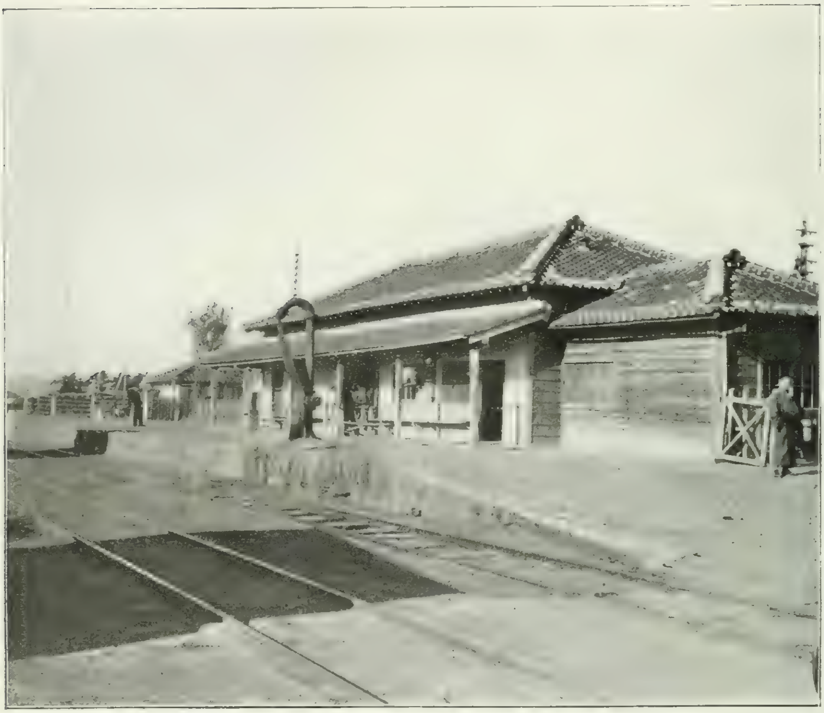
REVERSING STATION, BHORE GHAT INCLINE, GREAT INDIAN RAILWAY.
Showing substantial construction of road bed.

ment of so essentially an occidental idea as a railway, and of his own initiative to suggest, promote, and carry out new lines.

The case of Japan is peculiar. In 1855, prior to the visit of Commodore Perry, it was a country practically closed to the outside world, and was therefore far behind its neighbor, China, which had been carrying on trade with foreign nations for over three hundred years. In 1870 there was undertaken the construction of a line from Tokyo, the capital, to Yokohama, the chief port, a distance of 18 miles, and this began its operations in 1872. In 1893 the system had grown to 1,871 miles, and at the present time there are in actual operation about 4,000 miles.

AN IMPORTANT STATION ON A JAPANESE RAILWAY.

These railways are of three kinds: First, the government line, which constitutes the main stem, from Tokyo westerly along the coast through the great centres of trade and population, Yokohama, Kyoto, Asaka and Kobe; secondly, private lines, built with the aid of a government subsidy; thirdly, private lines, without government aid. Of the existing mileage, about 900 miles belong to the government and 3,100 miles to private companies, of which the most important is the Nippon Railway Company, whose lines run east and northeast from



A SMALL JAPANESE RAILWAY STATION.

Tokyo. The early Japanese lines were built by foreign, usually English engineers and operated by foreign managers. But nearly all the foreigners have been replaced by Japanese officials, three only—two in the operating and one in the tariff departments of the government employ—being retained. No new ones are now engaged, the natives having amply demonstrated their ability to do all the work of planning, constructing and operating.

The principal lines are double-tracked. Such single lines as exist are operated according to the English system of the train staff; and as the enginemen are natives, at wages averaging $12 per month, some such mechanical method, instead of the American system of telegraph dispatching, is a necessity. The track is of the American type, with flat-footed rails on wooden crossties and stone ballast. The rolling stock is of the European design, with cross compartments in the passenger cars and freight equipment of the "truck" order. The locomotives, on the other hand, are both European and American. In order to suit the passenger cars the stations have high platforms, and the buildings, though simple in design, are effective and usually models of neatness. Passengers are not admitted to the platform except with tickets, and are not allowed to cross the tracks except by an overhead bridge. The train schedules are generally generous in regard to frequency of trains, giving speeds of 20 to 30 miles per hour, with trains usually on time.

The results of operation are in every way satisfactory, and are sufficient to dispel completely any fear as to the Oriental failing to appreciate modern conditions when he has become used to them; for it must be kept in mind that it is only within the last few years that Japan has attained commercial prominence, and that it was but a short time since when she occupied a position inferior to other Asiatic peoples. The government lines earn per mile per annum about $8,000 gross, while the private lines, many of which are located in the sparsely settled and mountainous districts, succeed in averaging $3,500; but, owing to the low cost of labor, the ratio of operating expenses is much lower than is found in the United States, ranging from 40 per cent. to 50 per cent., thus giving a higher net return than is usual with equal gross receipts on railways in the United States.

Japan being an island, the railways are subject to junk and steamer competition, and as the Japanese coal mines are located on the sea,

A JAPANESE PASSENGER TRAIN.

such traffic is almost exclusively water-borne. The former condition deprives the railways of through freight, and the latter of coal and similar classes of heavy goods, except to interior points. The anomaly to American eyes in the returns is the fact that passenger receipts exceed those from freight, the ratio of earnings on the government lines being about as three to one, although on the private lines, where the population is much less dense, there is a nearer approach to equality. The same state of affairs is found to exist on the Indian system and on the Imperial Chinese Railway so far as it is built, indicating the existence of similar conditions of life throughout all the East. Contrary, therefore, to the ordinarily accepted belief, the Oriental is by nature a traveler when he gets the opportunity, and the extent to which he will travel is enormous. On the 660 miles of government lines in Japan, for the year 1898, there were carried no fewer than 28,000,000 passengers, an average per mile of 42,000. The average number of passengers per mile of railway in the United States is about 3,000. Taking a more striking comparison, the whole Japanese system, government and private, in 1898 aggregating 2,468 miles, carried 84,040,963 passengers, while the New York Central, in the same year, with 2,395 miles—or almost exactly the same length—carried 24,074,254 passengers, giving a relative density in favor of the Japan-

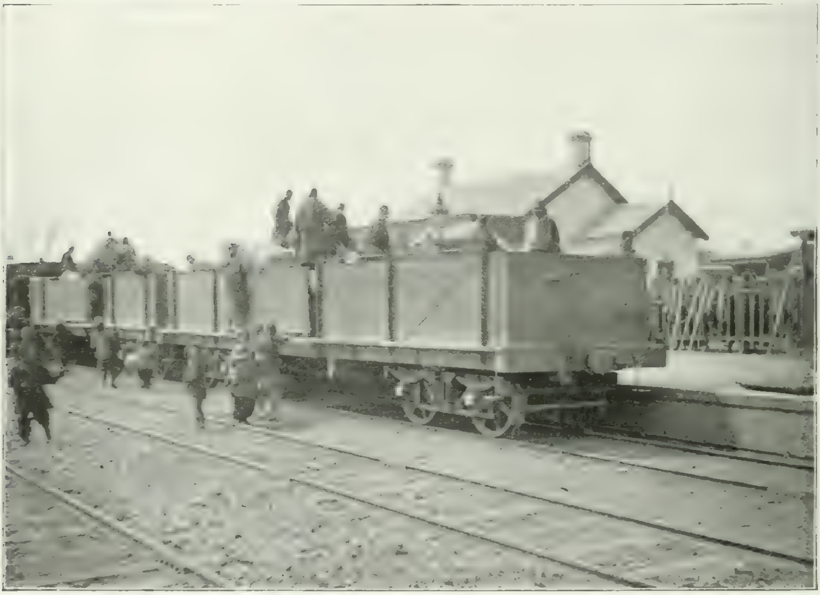
JAPANESE FREIGHT STATION AND FREIGHT CAR.

ese of more than three to one; and this in spite of the fact that the New York Central had the benefit of including among its passengers all the traffic received from western, New England, and other connecting lines. Even when making a comparison as to passenger mileage, the volume of business is in favor of the Japanese systems as two to one; the passengers carried one mile being in one case 1,438,014,632, and in the other 712,115,222.

Nor are the rates of fare at which this business is done so very low; in fact, some of the charges are so high as to excite the envy of an ordinary American traffic manager. In India there are four classes of passenger accommodation, the rates per mile ranging from 0.3 cent to 2.4 cents. In Japan there are three classes, the charges being 0.7 cent for the third class, 1.4 cents for the second, and 2.1 cents for the first; these last rates, adopted one year since, are an increase of one-third over the previous figures, it being found that the natives demanded better facilities and were willing to pay for them. On the Chinese Imperial Railway the rates are 1½ cents for first-class and ¾ cent second-class, at which prices, considering the shortness of the line, an enormous business is done. Although the rates for the lower classes seem low, it is to be remembered that the accom-

FIRST-CLASS CHINESE PASSENGER TRAIN AT A MEAL STATION.

modations offered are of the simplest and cheapest character, passengers in China being transported in open gondola cars. The charges for first-class travel in all countries are seen to compare favorably with American charges, again bearing in mind that the heavy, expensively decorated American coach is unknown. But freight rates are proportionately higher, the larger charges being rendered possible by competition with man-carried transportation, in which necessarily the cost is great. In India the freight tariff per ton per mile ranges from 1.6 to 5.5 cents; in Japan on ordinary goods from 1 to 2 cents with reductions for large consignments, and in China from 1.2 to 2.25 cents. In 1898 the average charge per ton per mile on the whole Japanese system was 1 cent, as compared with 0.6 cent on the New York Central.



USUAL TYPE OF FREIGHT AND SECOND-CLASS PASSENGER EQUIPMENT, CHINESE RAILWAY.

There is one form of railway development which as yet has made but little headway, but which is certain to attain great success, being peculiarly suited to the needs of the Chinese on account of the density of population, and the inherent tendency of the natives to individualize; that is, the electric trolley. The short journey will be the rule, and journeys made at all hours, rather than at fixed intervals, on a regular schedule. The electric tramway has just secured a foothold in Japan, in Siam, and in a few other isolated points; a few years hence will see its general application.

There is one curious feature in connection with Oriental railways, and that is the diversity of gauges, with the entailed certainty of all the inconveniences, delays, and unnecessary expenses that were experienced in the United States until a uniform gauge was at last adopted. The gauge of the Japanese system is 3 ft. 6 in., which is found to be inconveniently small; but as all the lines are alike, and as no outside connections are possible, it is not likely that any change will be made—at least, not for a long time. On the continent the matter is more complicated, and one that some day will certainly give trouble. The Russian Trans-Siberian Railway, and the Chinese Eastern Railway (which is the extension of the former through Manchuria, still nominally Chinese territory, to Port Arthur and to a connection with the Chinese Imperial Railway), has a gauge of 5 feet, in accordance with Russian standards. The Indian railways, on the other hand, have an assortment of gauges; one of 5 ft. 6 in., miscalled the "standard gauge," is used on the principal lines to the extent of about 14,000 miles. A gauge of 1 metre is in force on over 10,000 miles, while odd gauges of 2 ft. and 2 ft. 6 in. are found on a number of short lines, aggregating, however, nearly 1,000 miles. The Chinese authorities on the Imperial system in the north, and on the Shanghai-Woo-sung line, have adopted the European and American standard of 4 ft. 8½ in.; and as the same dimension is being followed by the Belgians on their Hankow-Peking line, and will be used on the English and American concessions, this will dominate the Empire, and to it in the end the Russian and Indian railways will have to conform.

As a field for the future, of course, China stands pre-eminent on account of its size, its population, and its well-known but undeveloped mineral wealth, offering chances and opportunities that are to be found nowhere else in the Orient. It is easily seen that the Chinaman was once an engineer of no mean ability, and the question now is whether he can become an engineer in the future, especially in transportation methods. Reasoning by analogy is our only means of answering. The Japanese, in his essentials does not differ radically from other Orientals. Starting from a point much inferior in the way of commercial development to the Chinese, he has built up, the greater part by his own individual, unassisted efforts, a railway system that can take rank with the railways of any other country. What he has done other Orientals can do, and will do, especially as the conditions for success on the mainland, with possibilities for through traffic and vast mineral deposits awaiting rail transportation outwards, exceed those of insular Japan. The engineering development of the Far East is bound to be one of the great achievements of the coming century.

THE INCREASING DEMAND FOR LIGHT-DRAUGHT STEAMERS.

By Waldon Fawcett.

PROGRESS in that branch of the ship-building industry which concerns the construction of light-draught steamers has, during the past few years, afforded a record of evolution so rapid as almost to suggest a new era of development. This has been due primarily to a number of contributory influences which have been exerted simultaneously, if not conjunctively, in both hemispheres.

Colonization and exploration have been elementary factors. This is well illustrated by the French, and more particularly the British operations in Africa. The campaign conducted by Lord Kitchener in the Soudan called into requisition light-draft steamers and gunboats as important adjuncts of one of the most admirable transport systems ever devised—not so much because it was of greater magnitude and more systematically conducted than āny of its predecessors, as by reason of the fact that it was based throughout on sound engineering principles. So, too, the more purely preliminary stages of the work having passed, the expeditions which under different flags have been engaged in the exploration of Central Africa have come to place an increasing degree of dependency upon the light-draught vessel. Finally, it became apparent from the very inception of the projects for a Cape-to-Cairo railway and telegraph that reliance would have to be placed on vessels of this class to supply, for a time at least, many important links in the chain of communication between the Soudan and the Cape.

Looking in another direction, a glance suffices for some comprehension of the field of usefulness which has been opened for shallow-draught craft by the construction of the Trans-Siberian Railway system. Much of the material for the construction of the line has been transported by river steamers and barges constructed especially for the work, and although the final completion of the road may abolish the present vocation of many of these boats as ferries on the direct and main line of freight and passenger transportation, they will yet find places as pioneers in the traffic of the new arteries of trade which the railroad will open up. The policy of the "Open Door" in China and the east would seem to insure a great future for the light-draught vessel in Asia. Her rivers are well suited to this class of craft—are, in fact, suited to no other—and the fuel supply and other factors to be taken into consideration offer no insurmountable barriers to their successful operation, while the profits in sight would seem to justify far greater risks than will be necessary.

In America, also, events have seemingly conspired in the creation of circumstances favorable to the development of this branch of marine engineering. Prominent among these might be classed the Alaskan gold excitement and the Spanish-American war. Some idea of the demand for light-draught steamers, induced by the opening of the gold fields in the most northerly possession of the United States, may be imagined when it is stated that ship-yards on the Atlantic and Pacific coasts, the Great Lakes, and the Mississippi river were engaged simultaneously upon the construction of craft designed for Yukon river navigation. The war in the Philippines and the acquisition of other new possessions resulted in an imperative demand for light-draught gunboats and steamers for war and commercial service on their rivers. In the case of the former the exigencies of

OHIO RIVER STEAMER CITY OF CINCINNATI.
307 feet long, 40 feet beam. Built at Howard's Ship Yard, Jeffersonville, Ind.

the situation in some instances necessitated the purchase of old vessels to meet immediate needs, but a majority of these will doubtless be replaced by vessels embodying more modern ideas of construction as soon as opportunity will permit.

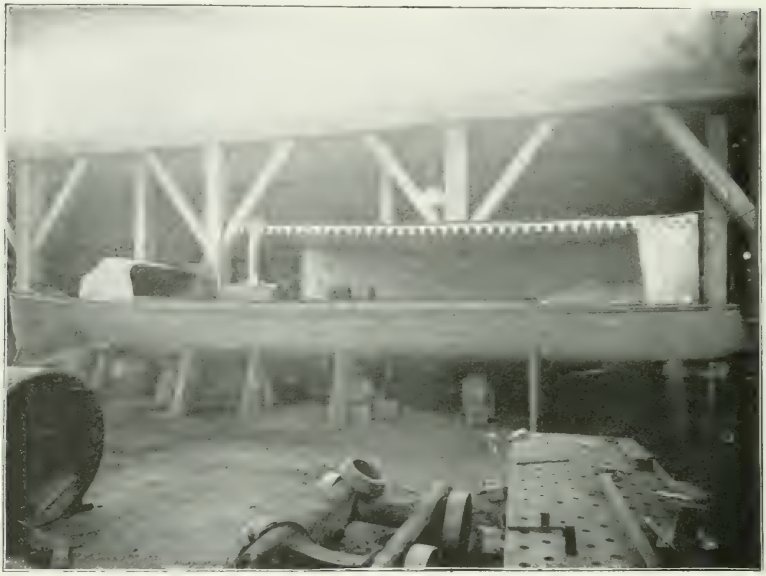
The advent of steel hulls in increasing numbers on the Mississippi and other inland rivers of the United States has not been without effect, and the field for high-class river craft would seem to be undergoing a continual betterment. As the development of Canada progresses, constant additions are being made to the fleet of light-draught steamers in service on her inland lakes, some of the vessels being built in Great Britain and others on the western side of the Atlantic. In South and Central America there is a nearly parallel growth, and here a natural inclination to rely chiefly upon light-draught steamers for purposes of transportation is very often coupled with necessity, owing to the character of the country. The trend of events, is however, well indicated by the fact that more orders for shallow-draught craft have come from South and Central American countries during the past half decade than in double that period at any time previously. Builders in the United States and Great Britain have shared in these commissions.

STERN-WHEEL FREIGHT AND PASSENGER STEAMER FOR THE ORINOCO RIVER, VENEZUELA.
Built by the Pusey & Jones Company, Wilmington, Delaware.

There are three types of shallow-draught steamers—the stern-wheel, the side-wheel, and the ordinary propeller type. Despite the fact that in boats of this class both speed and carrying capacity must of necessity be sacrificed to draught, something may be said in favor of each of the three types mentioned. The desire for slight immersion makes light construction throughout a prime requisite. This end is kept in view, not only in the case of the material put into the hull and in the distribution of machinery weights, but in the case of the machinery itself. Thus stern-wheel vessels are almost invariably recommended by the builders when a steamer is desired for exploring purposes, or for the navigation of rapids or narrow rivers—not so much because of the smaller breadth of hull as by reason of the simplicity of the slow-moving machinery and the fact that the location of the engines and boilers at the extremities makes it readily possible to distribute their weight over the hull by means of struts and bracing. The service in which some light-draught vessels are employed makes it expedient to equip them with locomotive-type boilers arranged to burn wood fuel; but in various vessels of the shallow-draught class in different parts of the world are to be found almost every imaginable kind of boilers, fitted for the consumption of the different species of fuel. The introduction of the water-tube boiler has been an important factor in more recent efforts to produce slight immersion, and present indications are that the utilization of its unique qualifications in this respect may be still further extended.

TWIN-SCREW LIGHT-DRAUGHT STEAM LAUNCH.
Built by Summers & Scott, Gloucester.

One of the surprising features of the construction of light-draught steamers is the rapidity which in almost all cases characterizes the building operations. Some of the vessels turned out at British yards for service in Africa and Russia were constructed, taken apart, shipped to their point of destination, and re-erected all within less than a year's time. The speediness of this work is shown in a new light by the record of one ship-yard on the Ohio river, which has,



LAUNCH FOR LAKE NYANZA, AFRICA.

42 feet long, 7 1-2 feet beam, speed 11 knots. Built by Thornycroft.

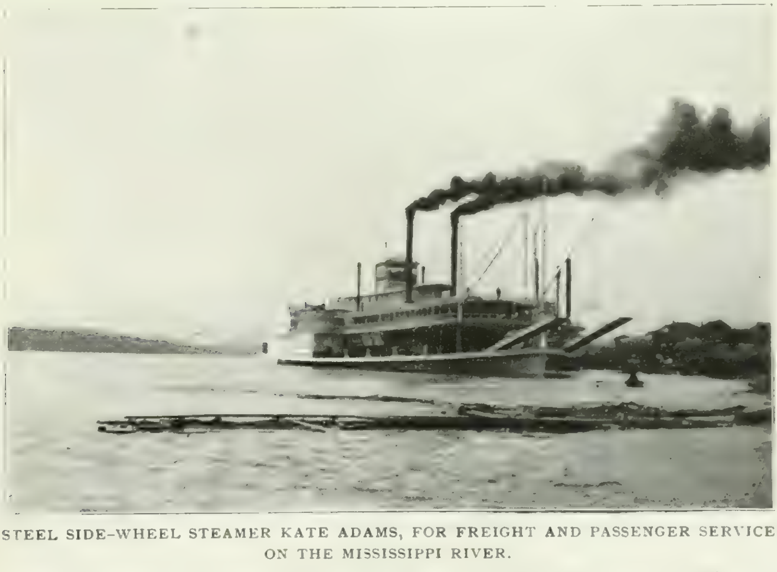
since its establishment a little more than half a century ago, turned out upwards of seven hundred vessels. That quick completion is not, however, secured at the sacrifice of efficiency, is proven by uncontrovertible evidence. The best of this is found in the fact that seldom, indeed, has any difficulty been encountered in putting together the vessels shipped in sections. Take, for instance, the case of the Union Iron Works of San Francisco, which some time ago filled a foreign order for eleven barges. All the material was gotten out from patterns and only one barge was put together for purposes of verification. The remaining ten were put together at their destination, and in no case was any difficulty encountered.

To take up first the subject of light-draught vessels on the Mississippi and other inland rivers of America, it may be stated that the fleet in service on these waters comprises no less than fourteen hundred vessels, all of which, of course, are of the class mentioned. There are on the rivers about a dozen ship-yards of some reputation and they turn out each year more than two hundred vessels, the aggregate value of which is not far from two million dollars. Nor can the great fleet of vessels on the rivers, controlled by the United States government, be overlooked. It comprises lighthouse tenders, survey boats, pontoons, barges, and towboats, almost all of them being under the control of the Mississippi River commission.

Ship-building practice on American inland rivers involves a pretty close adherence to precedent. Save in the matter of interior furnishings, one of the wooden steamers of given design is pretty much like another. Moreover, there has been almost no change in the general design in more than a score of years. Contemporary interest, therefore, is confined largely to the transition from wood to steel hulls which is now in progress.

How recent is the advent of steel plates for hull construction in the river ship-yards of America will be understood when it is stated that the Kate Adams, the first steel-hull side-wheel packet steamer built for passenger and freight service on these rivers, was not completed until late in 1898. The Adams, which was built at the yard of Capt. E. J. Howard, of Jeffersonville, Ind., for the Memphis & Arkansas City Packet Company, of Memphis, Tenn., may be taken as thoroughly representative of the most approved modern type of vessel for American inland-river navigation.

As strength had all along been sacrificed in the large wooden steamers to secure lightness of draught, the results from the adoption of steel in the hull of the Adams were naturally waited with no little

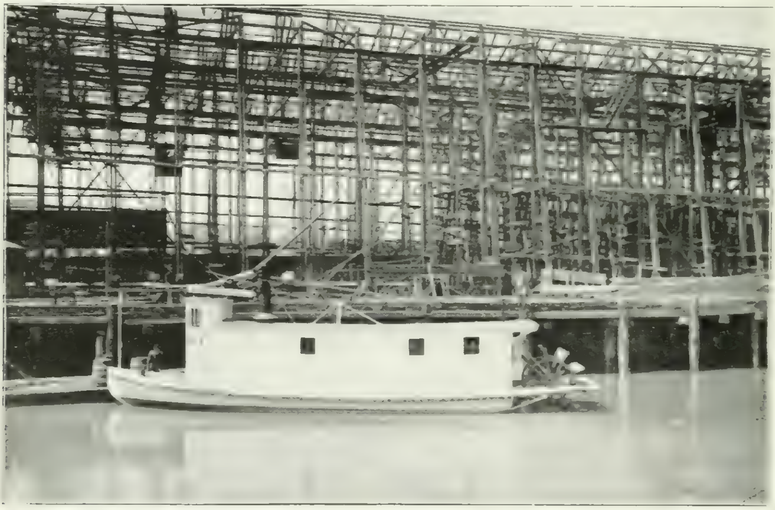


STEEL SIDE-WHEEL STEAMER KATE ADAMS, FOR FREIGHT AND PASSENGER SERVICE ON THE MISSISSIPPI RIVER.

250 feet long, 41 feet beam, 7 feet depth of hold, 3 feet 3 inches draught. Built at Howard's Ship Yard, Jeffersonville, Ind.

interest. Indeed, some of the builders on the river did not refrain from expressions of skepticism—or of incredulity—as to the advantages claimed for steel. Naturally, therefore, no little surprise was manifested when, after the new steamer had been completed and gone into commission with her complete outfit on board, her draught was found to be only 3 feet 3 inches, whereas two boats having wooden hulls, built at the same yard, of the same general dimensions and exactly the same engine and boiler power, each showed under similar conditions a draught of 4 feet 4 inches.

The Kate Adams is 250 feet in length, 41 feet beam, 7 feet depth of hold, and 5 feet sheer, and is fitted with three fore-and-aft and five athwartship watertight bulkheads. The hull plating on the bottom and sides is of 5/16 inch steel and the entire hull is double riveted, the cavils, bitts, and knees being of iron and steel. The engine is of 24 inches diameter of cylinder and 8 feet 9 inches stroke, and steam is supplied from four steel boilers 48 inches in diameter by 28 feet in length. A "doctor" is fitted for supplying the boilers, and there are also auxiliary pumps and injectors, an auxiliary boiler for electric-light and heating purposes, and a patent steam filter for filtering all the water used on board the vessel. The steamer cost $90,000; she has a freight-carrying capacity of 600 tons, and in regular service she travels a thousand miles each week, making during the journey more than one hundred and eighty landings.



MISSIONARY BOAT NORTHERN LIGHT, FOR THE YUKON RIVER, ALASKA.
Built by the Union Iron Works, San Francisco, Cal.

FLEET OF STEAMERS FOR THE YUKON RIVER ON THE STOCKS.

Moran Brothers' Company, Seattle, Wash., April, 1898.

Of the light-draught vessels for service on the Alaskan rivers there have been constructed many types, but all of them embody more or less of the characteristics of the river steamers on the Mississippi. One of the designs is that followed by the Moran Brothers Company, of Seattle, Wash., in the construction of a fleet of twelve wooden steamers for employment in the traffic on the Yukon river. Something of the staunchness of the craft is suggested by the fact that they weathered successfully the rough voyage from Puget Sound to St. Michaels, Alaska. The steamers—identical in every respect—are 175 feet in length, 35 feet beam, and 6½ feet depth of hold. They are stern

FLEET OF STEAMERS FOR THE YUKON RIVER, ALASKA.

Each is 175 feet long, 35 feet beam, 6 1-2 feet depth of hold, and draws 4 feet with 400 tons cargo. Built by Moran Brothers' Company, Seattle, Wash.

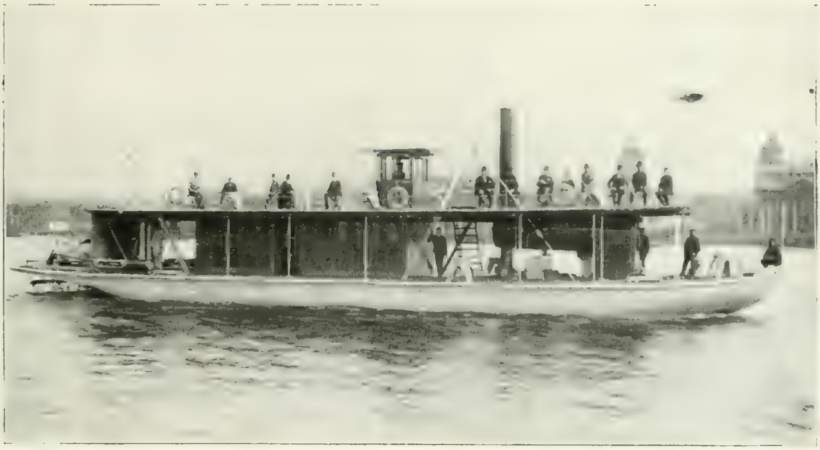
wheelers, with engines having cylinders 20 inches in diameter and 7 feet stroke. Steam is supplied from three cylindrical tubular boilers, 44 inches in diameter by 16 feet long. The steamers have all modern equipment, including an electric-light plant, and each vessel has a capacity of 400 tons on 48 inches draught.

Among the achievements in the line of ship-building for the Alaskan trade there stands out prominently the accomplishment of the Union Iron Works of San Francisco, which, during the latter part of 1898, constructed complete in 120 days a steel side-wheel tug boat of light draught for the service of towing the barges of the Alaska Commercial Co. between the mouth of the Yukon river and St. Michaels. This tug, christened the Saidie, is 157 feet 6 inches over all, 150 feet water line, 30 feet beam, 8 feet depth, and has a draught of 3 feet 4 inches. She is fitted with compound engines of 300 horse power, with cylinders 16 and 32 inches in diameter and 5 feet stroke. The wheels are 17 feet 6 inches in diameter, and the engines make, full open, 28 revolutions per minute. The tug has on several occasions developed a speed of 11 knots.

Among the European builders of light-draught steamers a promi-

LIGHT-DRAUGHT STEAMER SAIDIE, FOR TOWING BARGES FROM THE YUKON TO ST. MICHAELS.

157 feet 6 inches long, 30 feet beam, 8 feet moulded depth, and 3 feet 4 inches draught; speed 11 knots. Built by the Union Iron Works, San Francisco, Cal.



GUNBOAT FOR THE BRITISH GOVERNMENT, FOR SERVICE ON THE ZAMBESI.
Length, 77 feet, beam 18 feet, draught with steam up 18 inches; speed 10 miles. Built in floatable sections; ordered April 1, 1890, and completed May 3, 1890.
Yarrow & Co., London.

nent place must be accorded to Yarrow & Co., London, who have attained an international reputation by the construction of high-speed torpedo boats. Among the more interesting craft of this character which Yarrow & Co. built, as far back as 1877, was a shallow-draught stern-wheeler for the Hudson Bay Company. It was 120 feet in length and 24 feet beam, and had a draught of only 13 inches with twelve hours' fuel on board. With 70 tons of cargo the draught was 2 feet 6 inches. The hull was divided into fourteen compartments.

A few years later the British builders turned out two stern-wheelers for the conveyance of mails on the Magdalena river in the United States of Colombia, South America. These vessels were 130 feet long and 28 feet beam, and drew 12 inches of water with steam up, but without cargo, and 24 inches with 90 tons of cargo on board. The vessels were engined for 400 horse power each and developed a speed of 16 miles per hour. The seeming general preference for stern-wheel steamers, in the face of the fact that many experiments have proven that there is no perceptible difference in speed between a stern-wheeler and a side-wheeler of the same dimensions and power, is attributable to a number of causes. The stern-wheeler has a decided advantage in shooting rapids; the wheel is not so likely to be damaged by floating logs; and finally, it is available for service in narrower streams.

In the early eighties Yarrow & Company delivered to the Belgian government the steamboat Le Stanley, designed for service in an African expedition headed by the well known explorer whose name it bore. Five hundred natives were required to transport the vessel overland. It was composed of six oblong pontoons of galvanized steel, each 18 feet long by 8½ feet in width. The engines had one cylinder on each side of the vessel, the diameter being 10½ inches and the stroke 2½ feet. Le Stanley had a mean draught of 14 inches, and a speed of 10 miles per hour could be maintained.

Stern-wheel steamers of English construction have played a most important part in all the Nile expeditions, and have in many cases passed cataracts and waterfalls the navigation of which was regarded as impracticable by the military authorities. In one case, one of these boats for Egyptian service was completed in exactly seventeen days. Some of the vessels shipped to the Nile have been used as gunboats, being fitted with rapid-fire guns and shot-proof houses, and others have been employed for transport purposes.

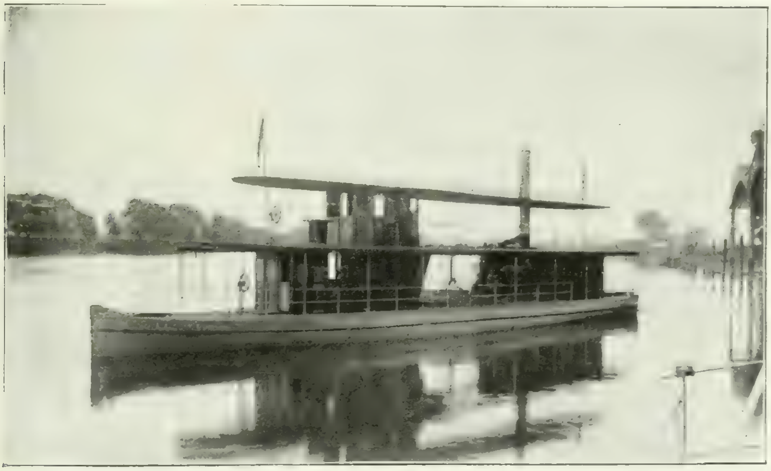
A SHALLOW-DRAUGHT GUNBOAT

Length 100 feet, beam 20 feet, draught carrying 25 tons, 1 foot 11 inches; speed 10 1-2 miles. Built by Yarrow & Co., London.

Shallow-draught vessels have been a specialty also with Messrs. John I. Thornycroft & Co., from whose works at Chiswick, London, many interesting craft have been turned out for service in all parts of the world. In 1881 they built for the Baptist mission on the Upper Congo, Africa, the Peace—a boat designed for a draught of water of but one foot when loaded with necessary fuel and stores and carrying four persons. The Peace was propelled by two turbine propellers, which were above the water line for one-quarter of their diameter.

In her trial trip on the Thames, she attained a speed of 12 miles. She was taken apart and shipped in a number of small packages, so as readily to be carried overland and re-erected by the natives on the waters in which she was intended to work. She had a water-tube boiler, which was in use on the steamer for six years, and afterwards furnished power at a land station.

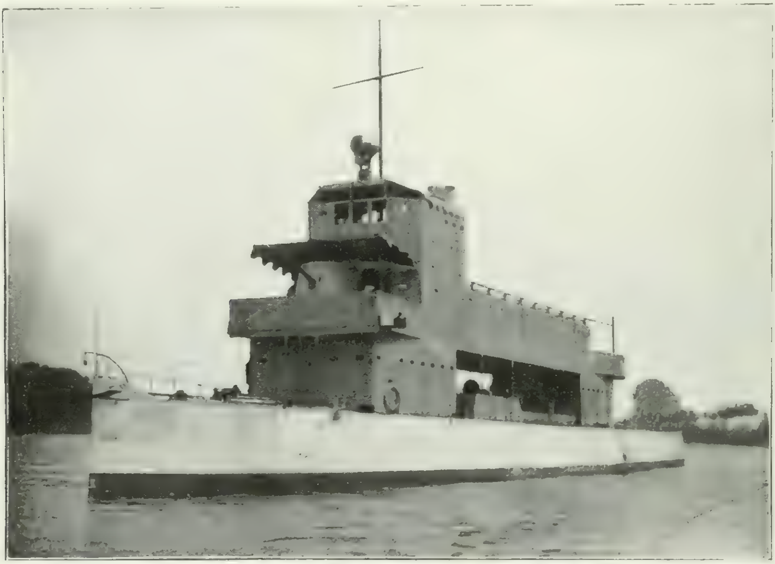
The Peace proved her value in the exploration of some of the tributaries of the Upper Congo. The Congo Free State, requiring a light-draught vessel at one time, requisitioned this steamer as the only one available. To avoid being thus cut off from communication with their stations on the Congo, the Baptist mission ordered a second vessel, the Goodwill, of somewhat greater carrying capacity and draught.



STEAMER GOODWILL, BUILT FOR THE BAPTIST MISSION ON THE CONGO.

84 feet long, 13 feet beam, 2 feet 2 inches draught; speed 10 1-2 miles. John I. Thornycroft & Co., Chiswick, London.

The vessel was built in 1891, and was equipped with a water-tube boiler, two turbine propellers, and compound engines; one propeller being worked by the high-pressure cylinder and the other by the low-pressure cylinder. She gives sleeping accommodations to eight persons, and draws 2 feet 2 inches with 13 tons of cargo. The river gunboat Melik, built by Thornycroft for service on the Nile, is a type of a powerful vessel of this class, being somewhat heavier and of slightly greater draught than the original patrol vessels built in 1885 for the relief of Khartoum. These had a length of 140 feet, a beam of 21 feet, and a draught of 1 foot 4½ inches forward and 1 foot 10½ inches aft. The dimensions of the Melik are: length, 145 feet; beam, 24 feet 6 inches; draught, 2 feet. She makes a speed of 14 miles with an indicated horse power of 457, and her load is 35 tons. All the plating over the machinery, and that of the upper decks, block houses, etc., is of chrome steel. Arranged as a passenger or cargo steamer instead of a gunboat, she would carry a load of 40 tons at the same draught and speed. The launch Sapucahy Mirim is a steam launch for Brazilian waters, built by the same firm, and made in five sections for transportation. She has a length of 56 feet 8 inches, a beam of 9 feet 11 inches, a draught of 1 foot 3 inches, and carries a load of 1.3 tons at a speed of 15 miles with 122 indicated horse power. Under trial, she towed a flat-ended barge containing 14 tons of ballast at a speed exceeding 8 miles per hour. The launch for the Magdalena river, illustrated on page 200, is a larger vessel 78 feet long, 12 feet 2 inches beam, and 2 feet draught, with compound surface-condensing engines of 190 indicated horse power under moderate forced draft, giving her a speed of 15 miles with 4.3 tons' load. She has three rudders, two at the stern and one forward. The Bygunbary is an example of the small steam launch, built for the Hoogli river. She is 30 feet 8 inches long, 5 feet 6 inches beam, draws 11½ inches with a load of ¼ of a ton, and makes 11¼ miles on 13 indicated horse power. Her engines are of high-pressure non-condensing type.



H. M. S. MELIK—A POWERFUL NILE GUNBOAT.

145 feet long, 24 1-2 feet beam, 2 feet draught; speed 12 knots. Built by John I. Thornycroft & Co., Chiswick, London.

SHALLOW-DRAUGHT LAUNCH SAPUCAHY MIRIM, FOR BRAZILIAN WATERS.

Length 56 feet 8 inches, beam 9 feet 11 inches, draught 1 foot 3 3/4 inches. Speed [illegible] miles. Built by Thornycroft.

The Sentinel Works at Glasgow, Scotland, of which Alley & Maclellan are proprietors, is an institution which has constructed some highly interesting examples of the stern-wheel steamer. Among the earliest of these vessels constructed at the Glasgow works were several steamers designed for ferry service in India. These vessels are 110 feet in length, 23 feet beam, and 4½ feet depth. These boats,

STEAM LAUNCH BYGUNBARY, FOR THE HOOGLI RIVER, INDIA.

Length 30 feet 7 inches, beam 5 feet 6 inches, speed 10 miles. Built by Thornycroft.

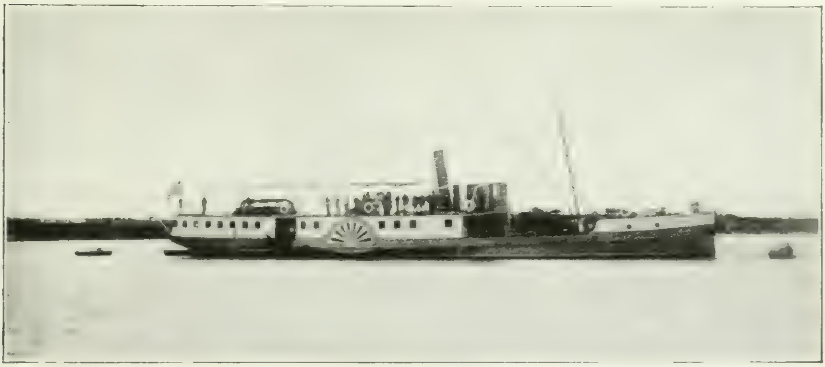
MISSION STEAMER CHAUNCEY MAPLES, FOR LAKE NYASSA, AFRICA.

126 feet 6 inches long, 20 feet beam, 8 feet 6 inches moulded depth, 6 feet draught. Burns wood fuel. Built complete, taken down, and shipped in sections.
Alley & Maclellan, Glasgow.

STEAM LAUNCH FOR THE MAGDALENA RIVER.

78 feet long, 12 feet beam, 2 feet draught. Built by John I. Thornycroft & Co.

with steam up and fully loaded, drew only about 2 feet of water and steamed on their trial trips 12 miles per hour. The firm also constructed, some years ago, four side-wheel paddle steamers for carrying passengers and towing barges on the Indian rivers. A paddle steamer, the Lady Margaret, constructed for passenger service on the English Channel, although of 144 feet in length over all by 32 feet beam, draws only 4 feet when fully loaded. Other paddle steamers turned out at the Glasgow yards for service in foreign waters—vessels 168 feet in length—have shown a draft of less than 2½ feet with steam up, fully equipped, and with stores, fuel, etc., on board. Other steamers of similar design, but a few feet shorter, have registered a draught of exactly 2 feet when loaded with 80 passengers, 20 officers and men, and with 10 tons of fuel aboard. The paddle steamer Guanaco, constructed for passenger and cargo service on the river Uruguay, South America, has a length of 151 feet and the loaded draught, with 80 tons of cargo and 100 passengers, is 36 inches. The Guanaco is fitted with compound engines having cylinders 16 and 31 inches in diameter and 40 inches stroke, to which steam is supplied from a boiler of the locomotive type having a heating surface of 934 square feet and suitable for a working pressure of 130 pounds per square inch.



STEAMER GUANACO, FOR FREIGHT AND PASSENGER SERVICE ON THE RIVER URUGUAY.
149 feet long, 24 feet beam, depth 5 feet 3 inches, draught 2 feet 6 inches. Built by Alley & Maclellan, Glasgow.

Of the screw steamers from the Sentinel Works decidedly the most interesting is the Chauncey Maples, designed for service as a mission steamer on Lake Nyassa. The vessel is 126 feet in length over all, 20 feet beam, 8 feet depth, and 6 feet draught. She is fitted with compound engines, the cylinders of which are 11 and 24 inches in diameter and 18 inches stroke. The boiler, which is arranged for wood fuel, is of the locomotive type, having 800 square feet heating surface and a working pressure of 150 pounds per square inch. The vessel was erected complete in the Glasgow yard, all the machinery, etc., being fitted on board, and was then taken apart and shipped to Chindi and from thence reshipped to the lake. For a considerable part of the distance the pieces had to be carried by native carriers. Another similar but somewhat larger screw steamer was shipped in sections to Hong Kong and there re-erected and engined.

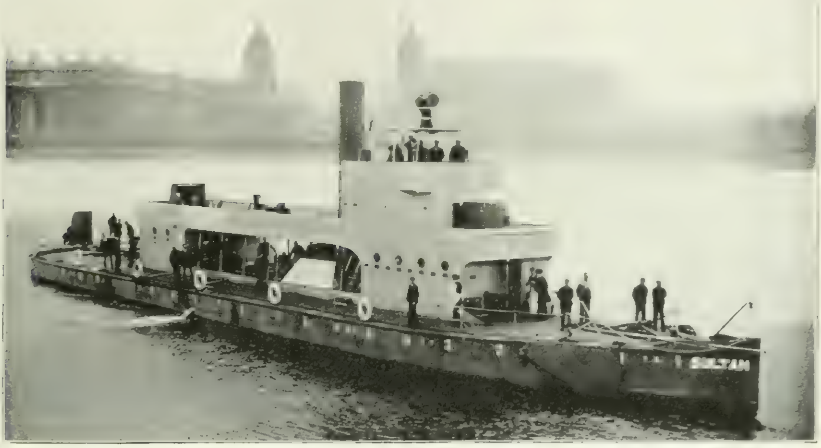
Both the French and Russian governments have gone away from home for shallow-draught steamers and in each case have secured vessels that are close copies of those constructed for the British Admiralty. The most interesting of the vessels constructed for the Russian authorities is a stern-wheeler of 100 feet length, which is capable of carrying an armament weighing 7 tons and fuel for 12 hours, steaming on a draught of less than 18 inches. The vessel made 11 miles on trial. The Opale, constructed for the use of the French troops in the expedition against the Dahomeyans in Africa, was a very similar boat and was proven to have deck space for the conveyance of 400 soldiers.

The latest approved practice in light-draught gunboat construction is demonstrated in the Sultan and sister vessels constructed by Yarrow & Co. for the Egyptian government. The Sultan is 145 feet in length and 24½ feet beam. The hull proper is 6 feet in depth, and carries a superstructure. The draught, with 35 tons on board, is 2 feet. The hull is built in eleven sections which are bolted together.

STERN-WHEEL STEAMER FOR THE RUSSIAN GOVERNMENT.

Length 120 feet, beam 22 feet, draft with 80 tons cargo, 3 feet. Speed 11 miles. Built by Yarrow & Co., London.

The vessel is fitted with two pairs of compound-condensing engines driving twin screws. The engines are capable of developing 600 indicated horse power, and the boat made on trial a speed of 13 miles per hour. The armament consists of two 12-pounder rapid-fire guns and a Maxim automatic gun.


SHALLOW-DRAUGHT GUNBOAT SULTAN, FOR THE EGYPTIAN GOVERNMENT.

Length 145 feet, beam 24 feet 6 inches, draught carrying 35 tons, 2 feet; speed 13 miles on a two-hour's run Built in floatable sections. Yarrow & Co., London.

All vessels previously constructed for service on the Nile had been stern-wheelers, but it was found that vessels capable of carrying guns of greater power at a higher level would be very desirable, and accordingly Sir William White, who, by the way, has always taken a great interest in shallow-draught vessels, designed the class above described. In these vessels the depth of the hull enabled the engines to be placed below deck, while the boilers, which extend above, are protected by a low superstructure.

The introduction of ordinary screws was, of course, out of the question; accordingly, two tunnels were raised in the bottom of the boat aft, and in each of these one of the twin-screw propellers revolves. The screws are 4½ feet in diameter and the tunnels, therefore, extend 2½ feet above the waterline. The working of the screws drives all air from the tunnels and its place is naturally filled with water, and, as the air once expelled cannot get back even into the portion of the tunnels above the water line, the screws are wholly immersed. The superstructure of the Sultan consists of two steel deck-houses, connected by a flying bridge 77 feet long and 13 feet wide, while above this is a bridge deck 14 feet in length and of the same width. Above this is a platform for the search light. The vessels of this class have in an emergency carried fully one thousand troops each.

A very interesting class of vessels is composed of the light-draught gunboats and unarmored vessels which have been added to the United States navy since the Spanish-American war. Some of these vessels are transformed tugs and yachts, but more than a score of them were captured from Spain or purchased by the United States War Department from that country after the cessation of hostilities. These are of the greatest interest by reason of the fact that they were built especially for service on the rivers of the new American possessions, a service for which the United States government will, in all probability, ultimately have to provide more modern craft.

U. S. LIGHT-DRAUGHT GUNBOAT ALVARADO, FORMERLY OF THE SPANISH NAVY.
110 feet long, 15 1-2 feet beam, 5 feet 6 inches draught. Displacement 100 tons. Built at Clydebank, 1895.

Men in all branches of the ship-building industry, from the naval architects to the builders themselves, are devoting a constantly increasing amount of attention to light-draught vessels. Indeed, the conditions in the new possessions of the United States, outlined above, the opening of the Nile, and the further development of Alaska, virtually necessitate this. Judging from the present outlook, it is not unreasonable to predict that the next few years will witness the introduction of more innovations than the closing quarter of a century.

THE IRON ORES OF THE LABRADOR PENINSULA.

By A. P. Low.

THE present high value of iron and steel, and the consequent activity in the search for and development of new sources of ore, make this a fitting time to call attention to the iron-bearing deposits of the Labrador Peninsula. Our knowledge of these ore-beds is derived from information obtained by exploring parties sent out by the Geological Survey of Canada into this vast and previously unexplored territory. The first mention of these ores was made by Dr. R. Bell in a report on an exploration of the east coast of Hudson Bay, 1877.* In this report he draws attention to thick beds of silicious spathic iron-ore, near the summit of the series of rocks forming the Nastapoka Islands, which stretch northward for nearly 100 miles from Little Whale River on the east coast of Hudson Bay. In 1893 the writer discovered, on the Kaniapiskau branch of the Ungava River, a large area of similar rocks containing a great thickness of cherty carbonates rich in iron, and underlying these considerable thicknesses of magnetite-hematite ores associated with red jasper and closely resembling the hard ores of Michigan, Wisconsin, and Minnesota. The following year a southern extension of this area was discovered on the upper waters of the Hamilton River. In 1895 a thick bed of magnetite, associated with crystalline limestone and pyritiferous, graphitic mica-gneiss, was discovered on the headwaters of the Manicougan River, separated from the Hamilton River area by a great mass of granite.

In 1896 the central area was found to extend northward across the Larch branch of the Ungava River, and the following season deposits of similar ores were discovered along the west coast of Ungava Bay. During an exploration along the east coast of Hudson Bay, in 1898-99, thick beds of magnetite-hematite ore were found underlying the spathic-ore beds of the Nastapoka Islands. The above summary

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Canada in the near future seems likely to be no mean rival of the United States in the iron and steel industry. Three great companies, with an aggregate capital of nearly $60,000,000, are already reported to be in the field, with a nickel-steel plant of corresponding size preparing for extensive operations.

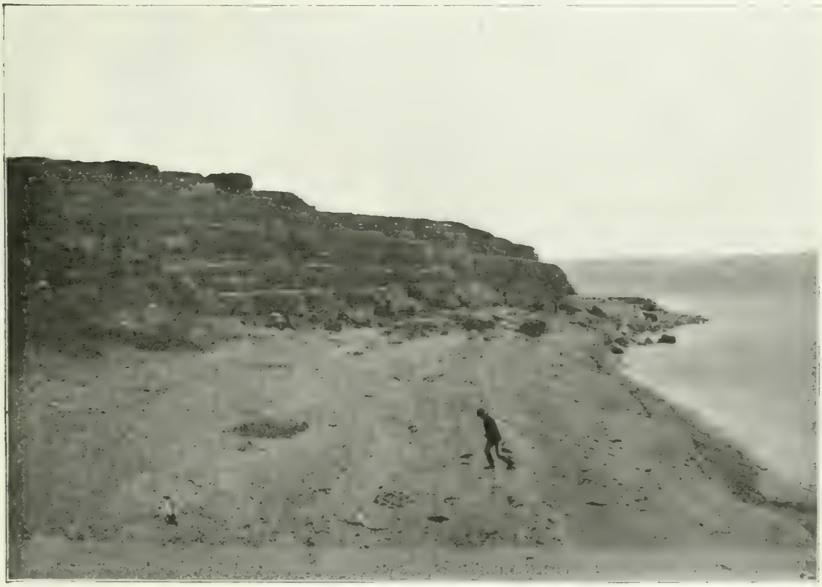
It is of particular interest therefore, to present Mr. Low's account of yet undeveloped iron resources in the Dominion. Mr. Low has recently returned from exploring the region and examining the deposits which he here describes.—THE EDITORS.

* Report of Progress Geol. Survey Canada, 1877-78, p. 21C.

BEDDED CARBONATE OF IRON CAPPING CHERTS, DAVIEAUX ISLAND, NASTAPOKA ISLANDS.

shows that on almost every lengthened exploration in Labrador extensive areas of valuable iron ores have been discovered, and with further exploration other areas will doubtless be found, some of which may be accessible enough to make the ore of great commercial value. The central area of iron-bearing rocks is the largest yet found in the peninsula; it stretches in a direction a few degrees west of north, from 54° N. latitude to beyond 58° N. latitude, thus having a known length of nearly 300 miles, while the average breadth is about 50 miles, giving an area of 15,000 square miles, with the iron-bearing strata developed over at least a third of the area. The magnetite area on the Manicougan River forms a band more than 100 feet thick, which may be traced westward from the river 40 miles to beyond the headwaters of the Outardes River. The deposits along the west shore of Ungava Bay have not been sufficiently explored to determine their extent. On the east coast of Hudson Bay the iron-bearing rocks occupy the islands and parts of the coast between Cape Jones and Cape Dufferin, a distance of nearly 300 miles. The cherty carbonates are met with on Long Island and other smaller islands in the vicinity of Cape Jones, on the islands of Manitounuk chain, between Great and Little Whale rivers; also on the Hopewell chain, immediately south of Cape Dufferin, as well as on the Nastapoka Islands, as already mentioned. The richer magnetite and hematite ores have been seen only on the last named islands.

The series of bedded strata in which these iron-ores occur bears a striking resemblance to the rocks of the iron-bearing formation south and west of Lake Superior; in fact, the resemblance is so close as to be marvelous in formations so widely separated in distance. The formation has an aggregate thickness of several thousand feet. The lowest beds are sandstones and conglomerates, formed evidently from the decay of earlier granites; these beds are followed in ascending order by red and green felsitic shales, dark blue dolomite, sandstones and shales, cherty limestones and black shales, ferruginous cherts, and black carbonaceous shales. The iron ores occur in the ferruginous cherty measures, which, in the central area, have a thickness of 850 feet. The rocks forming the central area and the coastal area of Hudson Bay are practically unaltered, except near their contact with masses of irrupted granite; the beds dip in the central area toward the N. E., or Ungava Bay, the angles of dip being usually under 30°, but the rocks are thrown up into a number of ridges at right angles to the dip by a force acting from seaward, which has buckled the formation and so caused a repetition of the beds in each of the ridges. The same thing has occurred to a minor extent on the coast of Hudson



BEDDED JASPER-MAGNETITE-HEMATITE ORE.

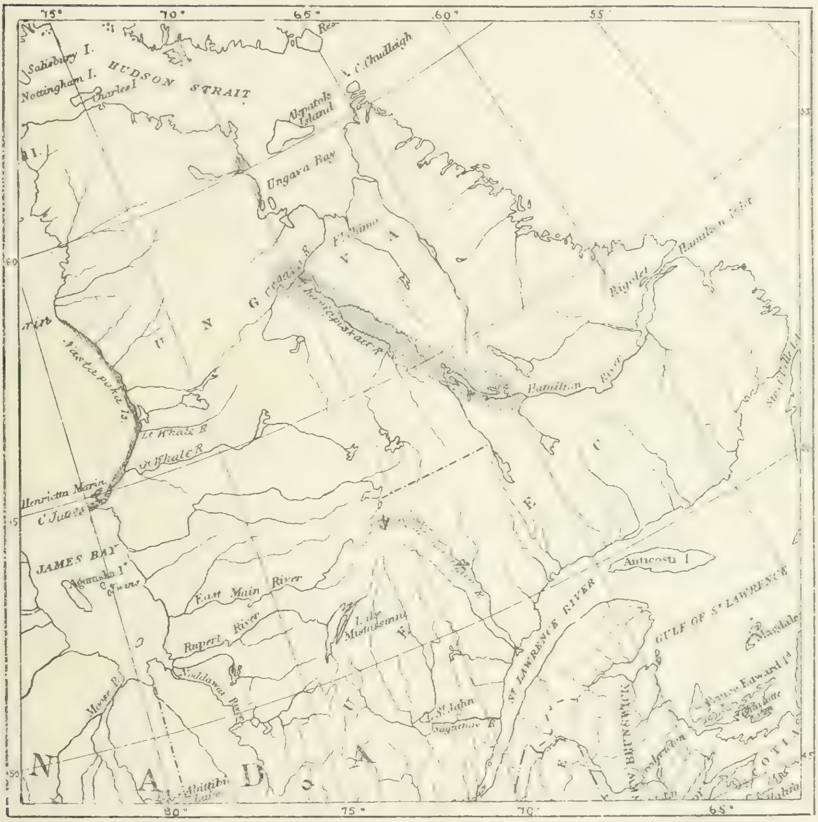
Ford Island, Nastapoka Islands, east coast of Hudson Bay.

Bay. Along the west coast of Ungava Bay a similar horizontal movement of the beds is complicated by intrusions of granite, which have changed the rocks into schists and the iron ores into magnetites similar to those of the Mesabi Range, west of Lake Superior.

On the Manicougan the rocks are surrounded by large masses of granite, which has completely altered them to crystalline limestones and gneiss, even the iron ores being in the form of a gneiss, made up chiefly of magnetite and quartz.

The ores appear to have been originally precipitated from solution in a shallow sea, the most common form of precipitate being a carbonate of iron, which is found throughout the measures associated with cherty carbonates of lime and magnesia in the silicious beds of the middle of the formation. These deposits of spathic iron occur most commonly in patches varying in size from minute specks to masses containing thousands of tons, and some of the silicious beds are largely composed of this ore, making workable deposits from one to ten feet thick. The richer deposits of oxides in the form of hematite and magnetite, or, more commonly, a mixture of both, usually occur near the base of the iron-bearing measures, and may be due to concentration, by circulating waters, of the iron from the leaner beds above, as

BEDDED MAGNETITE AND JASPER ASSOCIATED WITH CHERTS.
Lantz Island, Nastapoka Islands, Hudson Bay.



THE IRON ORE DEPOSITS OF LABRADOR.

Large deposits are shown by the shaded portions.

is held to be the case in the Lake Superior region; but I think this is not universal, and that in many cases the richer oxide ores may have been originally deposited as such in a manner similar to the deposits of oxides now forming in the lakes north of Three Rivers, Province of Quebec. Whatever their mode of formation may have been, we now find them, where unaltered, occurring as a mixture of hematite-magnetite, in bands varying from less than an inch to several feet in thickness and separated from one another by bands of red jasper, which also varies in thickness; so that, with varying proportions of both, the ore runs from an exceedingly rich one to a lean ferruginous jasper. The total thickness of these measures in the central area is about 500 feet, giving at least 200 feet of workable ore. On the Nastapoka Islands the rich iron beds are not so thick, and 50 feet may be taken as the workable thickness of good ore.

The following analyses were made from hand specimens, taken more for geological specimens than for ore samples, and are consequently not as good as might be found in large quantities in the localities from which they were taken, on the Kaniapiskau River. No. 1 is from a specimen of the cherty carbonate ores and may be described as a mixture of siderite and ankerite. No. 2 is from an exposure of 400 feet of the jasper ores, and was largely composed of hematite:

(No. 1.)	Ferric oxide	23.43	per cent.
	Ferrous oxide	21.32	"
	Manganous oxide	1.34	"
	Insoluble residue	6.72	"
(No. 2.)	Ferric oxide	80.17	"
	Ferrous oxide	0.35	"
	Manganous oxide	3.09	"
	Insoluble residue	13.78	"

No analyses have been made of the oxide ores from the other areas, but the following analysis of a carbonate ore from the Nastapoka Islands is interesting on account of the very large percentage of manganese present, which renders it very valuable as spiegeleisen for conversion with richer ores into Bessemer steel:

Metallic iron	25.44	per cent.
Carbonate of manganese	24.00	"

Under present conditions the ores of the interior and Ungava Bay are useless, owing to the lack of railway or other communication. The deposits on the islands of Hudson Bay lie immediately alongside of deep water, and so there would be no difficulty in loading on shipboard, but the long carriage through Hudson Strait and the shortness of the season of navigation (3½ months), are serious considerations in connection with the profitable working of these deposits. No coal exists about Hudson Bay, or in Labrador, and the wood for charcoal would have to be transported from the southern part of Hudson Bay to allow of smelting in the vicinity of the mines. The only supply of fuel in the neighbourhood is found in the great masses of driftwood on the islands and shores of the bay, and it is doubtful if this would answer the purposes of smelting. There are excellent water-powers in the neighbourhood, which might be used if a cheap method of electric smelting were discovered: otherwise it seems as if this area, along with the others, may long remain one of the undeveloped resources of the country.

WORKS MANAGEMENT FOR MAXIMUM PRODUCTION.

By J. Slater Lewis.

IT should be obvious that the advantages to be derived from the adoption of modern plant and organisation may be more than neutralized by the cost of labour or materials, by the action of trades-unions, municipalities, or governments, or by circumstances peculiar to local or national life in England and elsewhere. Perhaps in course of time many of these factors may have a universal standard of value, when all manufacturers will be on a fairly equal footing—except, perhaps, in regard to freights and packing charges, which will always remain in favour of those who can deliver their goods quickly without costly packing and at nominal transport rates. For the purpose of to-day, however, we must, in considering the profitable introduction of specialised machinery, reckon with things as they are, making reasonable allowances for future contingencies.

Some may ask: "What have all these subjects to do with the profitable introduction of specialised machinery?" I would reply: "Just as much as the theoretically correct disposition and arrangement of all the parts of a steam-engine or a dynamo have to do with the efficiency and economical manufacture of the finished article." Let any one item be wrongly disposed towards another, and instead of a good machine you have a bad one. But some may say: "Is it not then, altogether a question of technical education?" Well, technical education alone is not going to wipe out those engineers who have found the careful collaboration and dissection of commercial facts and probabilities the principal desiderata in locating, founding, organising, and controlling their works. Commercial traffic takes the line of least resistance, and neither technical education, specialised machinery, nor anything else will enable a man in India to make money by manufacturing snow-balls for Icelanders. A man may build a shoe factory in China, where labour is plentiful, and he may

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Mr. Slater Lewis' concluding paper, which gathers together and fastens in one center the lines of argument in his preceding articles, has been delayed in its appearance by his much regretted ill health.

Circumstances, however, give an unusual keenness of interest to the appearance of the paper at this moment. The United States have just felt the menace of a conflict like that which convulsed England's engineering industries in 1897. The lessons of Britain's experience are invaluable to those who are meeting the conditions through which she so lately passed. The outcome of the American situation is of the highest interest to European com-equip that factory with automatic machinery and every appliance calculated to cheapen production; still, if he had to buy his leather in America and find a market for his goods in France, where a hostile import tariff was in existence, he would find it hard work indeed to compete successfully with the Frenchman, who, although his works and plant and commercial organisation were not in accordance with modern thought and ideas, had leather in abundance at his door and a ready market for his shoes when he had made them.

Let us therefore analyse very briefly the main practical considerations lying around the subject before us.

Trade Unions.—These must be seriously reckoned with in the consideration of the subject, since the effect of their operations in various countries differentiates to a very important extent and consequently affects prices. As, therefore, trade unions have such an important bearing upon trade, it may lead to a better understanding if we trace briefly their origin.

We know that enterprising people prefer to *lead* and to carry others with them by the process of induction. We know also that others of less enterprising natures prefer to *follow,* and to be dragged along by the force of circumstances. Not many decades ago the bulk of the masters in Great Britain believed, unfortunately, in the short-sighted policy of regarding their men as so many machines, unworthy altogether of human consideration. Questions of hygiene, such as sanitation, light, and warmth, never concerned them, much less did questions of instruction. To lower wages and to keep their men in a state of subjection was the ideal principle of their profession. Any calculation with a view to proving the wisdom of providing for the comforts and the social and moral well-being of their men was beneath contempt. And what was the result? The best-skilled men, discouraged by that sort of thing, sought wider spheres, where their energies and intelligence not only met with due reward but have been the means of bringing home to us, and in very drastic form, the folly

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petitors. In view of the inevitable tendency toward apparently opposing organisations of employers and workmen, in both countries, it is indispensable to study the means by which such organisations may be brought into co-operation and harmony, instead of antagonism and discord. Trade unions, with all their defects and arrogance, are admitted to have wrought much that is intrinsically good. Employers' unions, directed with the broader view which is, or should be, theirs, should be yet more beneficent and freer from mistakes of motive or abuses of power. The movement, which was primarily militant, should be eventually all efficient in putting an end to strikes and bitterness.

The able and admirable paper by Mr. H. W. Hoyt, which leads this number of The Engineering Magazine, will be read with extreme interest. It defines the present situation in the United States and the purposes which dominate American industry in the adjustment of relations between employers and the unions.—The Editors.

of attempting to stem the tide of progress. It is, therefore, to the principles of that ancient species that we are indebted for trade unions. Revolutions are brought about by oppression and the grindstone of tyranny—never by trusting the people, nor by making a cringing community into full-blown men. America has, comparatively speaking, had little trouble with trade unions, all because careful observation, enlightened management, and scientific enquiry have taught her that urbanity of motive and cosmopolitanism of thought produce in the long run the best results, financial and otherwise.

However, trade unions having established themselves in Great Britain, what happened? English employers not only affected to ignore their claims, but had a sublime disregard for any kind of defensive organisation. It was only after enormous mischief had frequently been done to trade by strikes, and when business became almost impossible, that they suddenly and simultaneously discovered they had too long ignored the fact that an organisation for the protection of employers was of vital importance. Trade unions took advantage of the position in many ways and were busily engaged in the operation of forcing the manufacturers' hands by sectional tactics, which individual masters were powerless to cope with. A combination of the engineering employers and a costly lock-out became inevitable. Everybody remembers it. But it has put the British engineering trades on a sounder footing and has enabled manufacturers to begin the process of measuring swords with their foreign competitors. And, further, it has led to a better understanding between master and man, and has removed much of the deadly friction which hitherto existed. Whether this happy result in any way accounts for the abnormal success of the country during the past two years I cannot say, but the imports and engineering experts have beaten all previous records, and the revenue of the country is millions of pounds in excess of any previous financial period. Whatever may be said to the contrary, there can be no doubt that masters' unions and men's unions are alike desirable and necessary for the regulation of the labour traffic, and those who think otherwise only deceive themselves. But what the British manufacturer really requires is a levelling of wages the whole world over, and he should pray most earnestly for the success of the trade unions in those countries which do not at present enjoy the attentions of the representatives of those institutions. However, what we have to ask ourselves at the moment is this: "Is it possible under the present conditions of labour, or desirable under the prospective conditions attaching to trade unions, for Great Britain to attempt to manufacture goods profitably, by the introduction of specialised machinery, in competition with America and the Continent?"

THE COST OF LABOUR.—Between the *nett cost of labour* and the *hours of work* in America and England there is perhaps not much difference, but that there is a striking difference in the Continental practice no one will deny, inasmuch as the "working-day" on the eastern side of the Channel is much longer, and the rate of pay much less than obtains in either of the other countries mentioned. Perhaps some day our neighbours may be able to place a correct estimate upon their services, but for the moment their cheap labour and long hours tell heavily against English engineers.

Many arguments have been adduced by the workman's representatives with a view to proving that the British workingman is, after all, no better off than his friends on the Continent—in other words, that the British manufacturer has nothing to grumble about. It is, indeed, often contended that the ratio of wages earned to the actual net value of work performed is no greater in one case than the other. My experience, however, satisfies me that the contrary is the fact, and as cheap labour affects all industries, it follows that coal, coke, iron, timber, and other commodities will be affected favourably for the manufacturer, and that in consequence our Continental friends can cut prices below the British remunerative limit and yet secure a large share of profit for themselves.

Englishmen used to meet that particular aspect of the subject by the "made in Germany" excuse, but sarcasm soon ceases to have an effect when people's pockets are touched. The phrase answered its purpose for awhile, but the superior class of goods now manufactured on the Continent has turned the tables completely and "made in Germany" is now regarded as a valuable national trademark—one, in fact, in which Britishers would fain have never heard of!

THE COST OF MATERIALS.—The cost of raw materials is, more often than not, a matter of paramount importance to the manufacturer and cannot be ignored in the consideration of the question before us. It will be obvious that the manufacturing engineer who uses large quantities of heavy materials should be within the shortest possible distance of the producer, and should have railway sidings and the best facilities and appliances for the efficient handling of the material when it arrives at the works. If only small quantities of light materials are required, that particular feature of the internal economy of the establishment may be disregarded in favour of more important ones—such as access to suitable labour, water power, and good markets.

"PROTECTING" LABOUR.—The British government and the British municipal and country authorities, not content with the many burdens which manufacturers have to bear, must, forsooth, impose labour and fair-wage clauses upon contractors, which, when reduced to first principles, will not bear scrutiny at the hands of even the most thick-headed philosopher. For instance: "standard rates of wages" must be paid to all men employed upon a number of dynamos being made, say, for the British War Office. Now, if the *whole* of the *raw materials* used in the building of those dynamos were produced by the dynamo-maker himself, and were not purchased from outsiders, there would be some sense in the system of preventing "sweating," but no manufacturing engineer is independent of outside manufacturers. All have to buy something from the outsider, and here we often find the "sweater" in his most heinous form. He stands little chance of being molested. It is not the contractor of first instance, he who is compelled to pay standard rates of wages and who produces the bulk of his *finished materials* from his own *raw materials*—the sort of man who brings real solid wealth to the people—who gains by these arbitrary clauses, but the contractor of first instance who produces little from the *raw material,* and who buys most of his materials, not, perhaps, from the person whom we may call the contractor of second instance, but from the contractor of the third or fourth instance—those men who are never troubled by public regulations of any kind, and who "sweat" their men and women with callous brutality.

I am quite aware that, legally, permission has first to be obtained to employ the sub-contractor or contractor of second instance, but it is a rule more honored in the breach than in the observance. And what is the result? Why, the contractor of first instance, who buys the bulk of his material from the "sweater," can "wipe out" the genuine contractor, who produces his own goods in the entirety, and who, as the contractor of the first instance, is compelled to pay standard wages to all classes of labour.

The rottenness of such a system of "protection" becomes more pronounced when we ponder over the fact that any article of foreign manufacture will be accepted by these public bodies and paid for without any inconvenient questioning as to rate of wages or hours of labour. This phase of the question needs to be carefully considered in connection with the subject of Works Management for Maximum

Production, since it is rapidly becoming a question not so much of "What *can* we do" as "What *may* we do?"

FREE TRADE *versus* RECIPROCITY.—I do not propose to say much regarding this question, but one thing is clear—that the Americans and all our Continental friends not only have large markets of their own, but a free and open door into the vast English markets. The combination of those two factors is of supreme importance in connection with the subject of "mass production," where quantity and the extent of the field of operations are the very soul and essence of success. The British manufacturer, go wherever he will, is opposed by tariffs not only prohibitive in magnitude but "ad valorem" and hostile in spirit. When Great Britain was regarded as "the workshop of the world" and other nations had no alternative to buying British goods, it was a case of "Hobson's choice"; but now that half a dozen other countries have manufacturing pretensions and facilities at least equal, if not superior to those of England, it must be obvious to the most obtuse that unless the one-sided conditions now existing are modified, our operations will be closely invested by the enemy; Britain's position as a manufacturing nation will be no longer in the ascendant, and mass production, from an English point of view, will be robbed of its principal charm.

THE THEORETICAL AND TECHNICAL ASPECT.—This side of the question of mass production is of course a very important one—one which varies with circumstances, such as public requirements and tastes, the necessity for cheap workmanship combined with lightness and high efficiency, or—the reverse of that—the very highest possible class of workmanship in machinery of substantial proportions, where efficiency, as applied in the technical sense, is necessarily and purposely disregarded.

Here we approach a phase of the subject so vast in extent that I must be excused making more than a few remarks anent the fashionable or prevailing idea that technical education alone is going to "run the show" in future. The term technical education very often reminds me of the old saying—"The theory of music is one thing—playing the instrument another!" A learned professor may enlarge for an hour or two upon the art of driving a nail, or driving a golf ball; but the student, and perhaps the professor himself, might find the first few attempts at driving either the one or the other to be associated with some little surprise, if not with damage to person and property. It is the same in most things. The youth who "works" his skates for the first time or two, will learn more in five minutes about "contingencies" than he will by studying the theory of skating for a life-time.

Technical education without practice will not enable a man to jump right into the arena of industrial warfare and fight all comers—nor will it give him initiative, "grit," rough-and-ready common sense, determination and energy, or the peculiar faculty of making hard bargains and finding the best market for his goods. Neither will technical education alone give a man an eye for the beautiful, the graceful, or the practical. All those qualities are in-born to a large extent in the most successful men. Very often young children have pronounced tendencies and striking individualities and ideas long before they even have made the acquaintance of the A. B. C. of their education.

It must not be assumed from the foregoing that I am a heretic in the religion of technical education. I am nothing of the kind. I regard technical education, to a certain extent, as being the only door to success. When, however, it attempts to make a man *understand all things at all times*, it becomes a farce and a clog to progress and ruins the prospects of thousands of young men—men who have aimed too high for their real abilities or opportunities. Technical education, by which I mean technical education in one branch of trade or in one profession, is of vast importance to the youth who wishes to be, *not* a walking authority upon every conceivable subject, but thoroughly well versed in and fully equipped for the particular business or calling which he has chosen for his future career.

Take the man who wishes to become a leading gun maker. He must not only understand the theory of the gun, as well as of the explosive, but be a mechanic of the first water. If he wishes to make guns in large quantities, he must be fully acquainted with the most modern machine tools and be capable of taking full advantage of even the most minute improvements in the manufacturing processes. Greek, ancient history, and a perfect knowledge of all the classics would be of about as much value to such a man as a knowledge of dress-making. I had recently the opportunity and the gratification of being shown over a foreign gun factory, and I was assured that the cost of the labour and the material in connection with an extremely well-finished and handy little rook-shooting rifle was four shillings and two pence. The man who wishes to out-step the results in that establishment would have to begin very early in a morning, even if he carried a technical school about with him in his pocket.

Mass production has reduced the cost of labour in guns, bicycles, sewing machines, and many other similar goods, to a bed-rock condition of things, and nothing but an extensive experience in each branch of business, with a full and wide-awake knowledge of all the tips and tricks of the trade—both technical and practical—will enable a man to keep abreast of the times, much less to wipe out his opponents.

There is no royal road to success in the matter of the organisation and the working of factories where mass production and standardisation are the dominating features. It may not be altogether a question of the best machine-tools, nor of the design of the article to be manufactured, but one, perhaps, of commencing operations by efficient "jigs," careful checking of operations as they proceed, and many other considerations which can only be acquired by experience and by coming into contact with the best men and the best appliances.

Some people believe in making themselves into professional men first, and engineers afterwards. They bang away at every conceivable technical subject till they are bald and then emerge into the world in search of employment. If they have a fond parent with a long pocket, and are favoured by opportunity and possessed of patience, energy, and gumption, they may ultimately succeed in life; but without those qualities and advantages they stand a poor chance indeed. Let me illustrate the meaning of all this by quoting a passage from a letter which I recently received from an old engineering friend in America. It is particularly pertinent to this subject, because we are here dealing with a matter which has called forth the best energies of the professorial element, in the endeavour to prove that the technical school is the only channel through which money—for that is what most people are striving for—is to be made.

"Hang any and every profession! The average counter-jumper makes a better living than a professional man—and indeed, in nine cases out of ten, the commercial man is more valuable both to himself and humanity at large than the professional man.

"The insight which I get in the working of the greatest corporations on earth confirms this view to me, and I fully believe that the men who plotted out the time-tables and organised the Pennsylvania Railroad System are *at least* as capable and valuable as the engineers, bridge-builders, and others who built the line. I am, of course, an interested observer and may be wrong in my conclusions, but I see it clearer every day that the best engineer is the one who does most with the least means, and that success and reputation follow concentration of energy, applied to one particular field 'which *can* be developed.'

"I engaged a man last week who is a thoroughly competent architect. He built villas abroad and can lay out a cathedral in a 'jiffy'—or a synagogue, which would deflect all the traffic if erected near any stock exchange—he has a wife and children, but no overcoat, and I let him make tracings and am not quite sure whether he will maintain himself on this work even!"

How sad! But it is only the case of many draughtsmen over again. I have known quite a number of young fellows who have been thoroughly well educated; who were splendid draughtsmen and who had had a technical training of the "heavy" order—yet earned much less than fitters and turners in the shops, and had to keep up appearances. They were, however, short of commercial knowledge; knew nothing of handling men, nor of the great world of hard experience through which the successful mass-producer has to travel almost barefooted!

CONCLUSION.

It will be seen from this and previous articles that establishing new works for the profitable introduction of specialised machinery in order to arrive at maximum production is a matter of great complexity, involving questions of the highest importance, which must vary in accordance with the surroundings of each particular trade.

For me, therefore, or any other man, to attempt to lay down a set of hard-and-fast rules for the profitable introduction of specialised machinery for any and all classes of work would be impossible, and would be only imposing upon the credulity of my readers. In my treatise upon the "Commercial Organisation of Factories" I have dealt with system and organisation as the cardinal principles underlying successful shop management—whether it be a shop where articles are manufactured in large quantities or in small. System and organisation studied and practised with keen and enthusiastic intelligence, will bring out most of the good qualities essential to "Works Management for the Maximum of Production."

In concluding this series of articles I cannot do better than quote the words of a well-known American engineer—Mr. Tregoning.

"It has been said that 'system is the triumph of mind over matter,' and there is no doubt about the truth herein contained; we only get suspicious of the fact when taking a measured survey of the inner workings of some large factories, and gaze sorrowfully at the triumph of matter over mind.

"To work systematically is to work successfully. Method is the essential element on which every solid and substantial concern is based; and that factory, institution, or establishment of any kind which ignores it, conveys to the observer an impression that nothing permanent or abiding is intended, whilst on the other hand a systematised manner of working stamps it at once with permanency—an establishment that means business and intends to carry it on for all time.

"I have heard it remarked that in business three things are necessary: knowledge, temper, and time; but I have seen all three prostrate and powerless for want of *method in the management.* Such is the evil of working in an unmethodical and slipshod manner, that it is not too much to say results have followed well-nigh ruinous to the concern.

"There is no doubt that the subject of factory organisation has been badly neglected in past years. That we have *not* advanced with the order of the times is the complaint I lodge against the doors of many managers. We are working on old systems which have served their day and generation—systems which 'have had their day' but, unfortunately have *not* 'ceased to be'; for a brief glance at many of them, both great and small, will prove that little or no method is used, and that the concern moves under conditions which are disgraceful; the wonder is how it moves at all. My observations have led me to conclude—and I say it after twenty years' experience—that the first and foremost want of many of our large factories is not *work,* but a thorough revision of the machinery that manages and directs the whole concern. It is not a want of brains, it is not the difficulty of working out a vast and complicated scheme, it is not a matter involving the company in a large outlay of money—it is simply a question of *method*—the application of a few simple rules, and a respect for the time-honoured principle that order is the first law of the universe, and the nearer our approach to it the more harmonious will our arrangements work.

"A perfect organisation I consider an essential and vital element in securing success, in whatever form of institution we may wish to carry on, whether political or religious, mechanical or social. I contend that it is not possible to found a lasting power upon a management in which systematic action is eliminated or ignored; a ramshackle condition of things is the ultimatum; and in many cases establishments have closed simply through a break-up from within of its *managing machinery.*"

THE EFFECTIVE LUBRICATION OF JOURNALS.

By F. W. Graham Snook.

MICHAEL ANGELO, on pointing out several alterations of detail in a statue, was met by the exclamation that they were but trifles. "Ah!" he replied, "trifles make perfection, and perfection is no trifle."

The remark is no less true of machinery; and of the many details of an engine none receives less systematic attention than the lubrication of bearings. This is all the more astonishing when it is considered how large a part the element of journal friction has played in the development of engine building.

The general application of the screw propeller to ship propulsion was long delayed by the difficulty of producing an engine to run at the speed of revolution necessary to the screw's efficiency. The introduction of the old geared engine is evidence of the trouble met with.

With the advent of the direct-coupled engine hot bearings became the bugbear of the engineer, and his thanks are mainly due to torpedo-boat engine builders for the now universal recognition of the fact that not only must a bearing be strong enough to withstand the stresses put upon it, but ample surface must be provided to prevent the viscosity of the oil being overcome and the unguent squeezed out.

It does not follow, however, that because a journal runs without heating its friction cannot be reduced, and it is the privilege of the quick-revolution dynamo-engine makers to have enforced the lesson that the method of introduction of the lubricant to the bearing is at least as important a consideration as the giving of sufficient area to the rubbing surfaces.

The torpedo-boat engine builder produced a smooth-running, quick-revolution engine; the dynamo-engine builder has demonstrated the gain in mechanical efficiency to be attained by means of an automatic system of lubrication scientifically applied.

If engine builders would but roughly estimate the waste of time and amount of trouble caused by hot bearings in engines before they have completed their trials, and if owners would take the trouble to find out the gain in mechanical efficiency and in diminished wear-and-tear from the adoption of an efficient system of lubrication, both would grasp the money value of attention to this detail of manufacture.

The use of the matter relating to Mr. Beauchamp Tower's experiments is by courtesy of the Council of the Institute of Mechanical Engineers.

Much attention has been given to the reduction of steam consumption per indicated horse power, but the relation of indicated horse power to brake horse power, or to horse power of useful work done, has received comparatively little attention.

When it is considered that in an ordinary engine working at full power, about 8 per cent., and at one-quarter power, about 35 per cent. of the power developed is wasted in journal friction, it will be seen that there is much room for progress in the direction of the reduction of this loss by more careful attention to oiling arrangements.

The extent to which journal friction depends on the manner in which the lubricant is fed to the bearing was most clearly demonstrated in 1883 and 1885 by Mr. Beauchamp Tower's experiments on behalf of the Research Committee of the Institution of Mechanical Engineers, and recorded in their Proceedings of those and subsequent years. An apology would be necessary for referring to information so old, especially in view of the comment it raised at the time of publication, were it not that engineers persist, with a strange conservatism, in their preference for a system which attempts the introduction of the lubricant to bearings at the worst possible point—that of the greatest pressure, or the crown of the bearing.

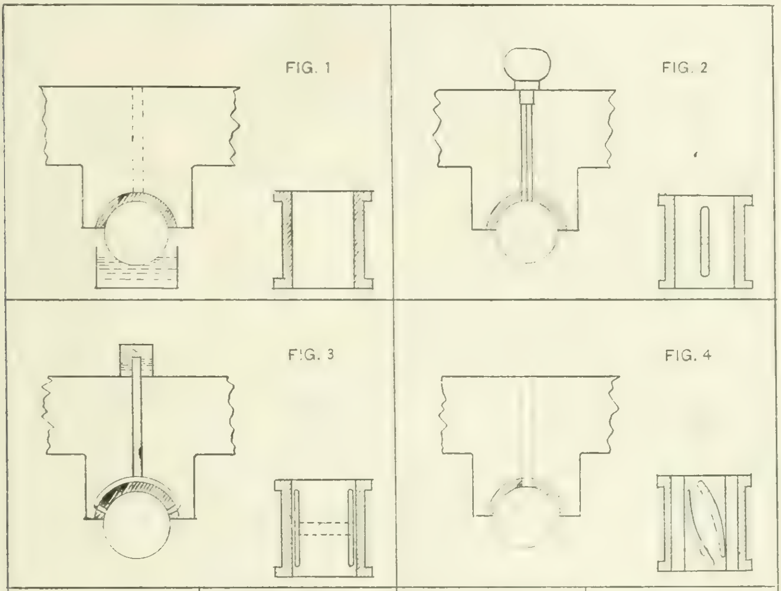
Referring to Fig. 1 it will be seen that in the experiments referred to a journal was used of 4 inches diameter and 6 inches long, with a top brass only which could be loaded as desired.

The journal was first lubricated by being run in an oil bath, the bottom of the journal just touching the oil. Fig. 1. (The oil hole shown by dotted lines has no connection with this experiment. The brass was plain, with no groove or hole).

Then the oil was fed in through a hole in the top of the brass, after the usual manner, by a syphon lubricator. The form of brass was that of Fig. 2, and the lubricator that of Fig. 3. Finally, the oil was supplied from a pad on the underside of the journal which received its oil by capillary attraction only, the conditions being, except for the oil bath, those of Fig. 1.

By reference to the table it is seen that if the friction with the oil bath method be taken as 1, that developed when using the syphon method was 7.06 and with the oily pad it was 6.48. The load was practically constant.

With the bath lubrication the shaft was, of course, wet with oil; with the pad the oil was just perceptible to the touch, and it could not be felt at all when fed by the syphon. Thus we see the lubrication can be so diminished as to make friction seven times greater with one method of supply than with another, and yet the bearing will run without seizing. Hence the method of lubricating journals is of such importance that it may be well to recapitulate some of Mr. Beauchamp Tower's further experiments, to show that the usual method obtaining to-day is by no means the most efficient.



	ACTUAL LOAD IN LBS. PER □"	CO-EFFICIENT OF FRICTION	COMPARATIVE FRICTION
OIL BATH	263	.00139	1
SYPHON LUBRICATOR	252	.00980	7.06
PAD UNDER JOURNAL	272	.00900	6.48

PLATE I.

In the course of the oil-bath experiment already mentioned, a hole was drilled in the top of the brass to take an ordinary lubricator (see dotted line in Fig. 1), when it was found that the oil, picked up by the journal from the bath underneath, filled the hole and overflowed. A wooden plug was driven in only to be forced out by the oil. A pressure-gauge screwed into the hole recorded a pressure of more than 200 pounds per square inch, clearly proving that the brass was floating on a film of oil subject to the pressure of the load, and there was consequently no metallic contact between the bearing surfaces. The oil-bath method was found most efficient, as the bearing could be loaded to 625 pounds per square inch before seizing.

The next method tried was with a common needle lubricator, and grooves were cut in the direction of the length of the brass from a centre hole, as shown in Fig. 2. With a head of 7 inches, the oil refused to enter the bearing, which would not run cool with so small a load as 100 pounds per square inch. The oil hole was then filled up to the top with oil and the weight eased off for a moment. This allowed the oil in the hole to sink and lubricate the journal, but almost immediately the load was again allowed to press on the shaft, the oil escaping by the path of least resistance, or least pressure—the oil hole—rose in it to the former level and the journal became dry. Thus it is clear that, instead of being a means of lubricating the journal, this very usual groove-and-hole method was a most effectual one for removing all oil from it.

The centre of the brass being obviously the wrong place to introduce oil, holes and grooves were made as in Fig. 3. The oiling by this method was apparently satisfactory at light loads, but the bearing nevertheless seized with an actual load of 380 pounds per square inch. The grooves were then cut after the manner of locomotive axle boxes, and the oil introduced through two holes and grooves as in Fig. 4. The chord of the arc of contact was reduced from 3.9 inches to 2.25 inches. The lubrication was again so imperfect that with a head of 9 inches the underside of the shaft was quite dry, and the journal would only run with a load of from 175 to 200 pounds per square inch.

This is rather an extraordinary result, as car-axles are found in practice to have a coefficient of friction as low as 0.01, but this is probably due to vibration and end-play allowing a free flow of lubricant. The effect here is similar to that obtained by frequently striking from below a table over which a weight is being dragged, and has been called "dithering" friction.

The next experiment was a step back in the direction of the oil bath of Fig. 1. The journal was supplied with oil from a pad touching the underside, the bath having been removed. Though the oiliness of the journal was scarcely to be felt, it was evenly distributed and the bearing ran with from 551 to 582 pounds load per square inch, but seized with this after a few minutes' running. These experiments then show conclusively the futility of attempting to introduce the lubricant on the pressure side of the bearing.

Arrived here, the next question is palpably: "How is the pressure distributed on the pressure side of a bearing that we may know where to introduce the lubricant to the journal?" This is best answered by reference to a subsequent experiment of Mr. Tower. Having already found that the oil pressure in a bearing could be recorded by a pressure gauge, three ¼-inch holes were drilled lengthwise in the body of the brass and through a little more than half its length, as is shown by Plate 2. One hole is in the centre and the other two are on each side of it (Fig. 2). These holes, coming out at one end of the brass, were connected by converging copper pipes to a Bourdon pressure gauge. In order to ascertain the pressure at any point between the brass and journal, a hole of 1-16 inch diameter was drilled from the bearing surface of the brass into one of these longitudinal holes, thus making connection between that point and the pressure gauge. The pressure having been ascertained, the hole was stopped up and another drilled, and so on. The arrangement of the holes, which were successively tested, was as follows: The brass was supposed to be divided by six vertical planes—three parallel to the axis of the journal and three at right angles to it. The test holes were situated at the nine points of intersection of these planes. Of the three planes parallel to the axis of the journal, the one on the side where the surface of the journal enters the brass is called the "on" plane, the direction of rotation of the journal being indicated by the arrow in Fig. 2. That which passes along the axis of the journal is the centre plane; the remaining one, on the side where the surface of the journal leaves the brass, is called the "off" plane.

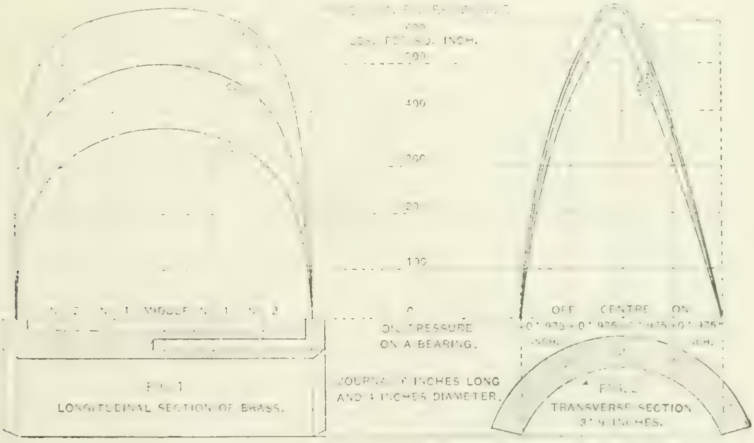


PLATE 2.

The pressure was thus actually read at nine places in the bearing, but as it is reasonable to suppose that the pressure must be symmetrically disposed on each side of the middle transverse plane, the pressures were observed on one side only of that plane and those on the other side assumed to be the same, so that in reality the pressure may be considered to have been ascertained in fifteen different places distributed over the whole bearing surface of the brass. By the curves it is seen that the pressures per square inch are as follows:

Longitudinal Planes.	On pounds.	Centre pounds.	Off pounds.
Transverse Plane, Middle	370	625	500
Transverse Plane, No. 1	355	615	485
Transverse Plane, No. 2	310	565	430

The greatest pressure is seen to be on the "off" side of the centre, the pressure at the holes of the "on" side being in every case considerably less than at the corresponding ones on the "off" side. The line of greatest pressure, while very slightly to the "off" side of the centre, is almost exactly where the oil hole is made in the ordinary bearings of engine.

Let us now return to the experiments on the different methods of oil supply and examine the result by the aid of this last experiment. Taking first the gravitation method, with the grooves in the brass, Fig. 2, page 223, it was found impossible to run the journal when loaded to only 100 pounds per square inch. In the light of the last experiment, it is evident that as oil hole and groove are along the line of greatest pressure in the brass, the oil could not possibly force its way in. With the arrangement of holes and grooves as in Fig. 3, the result was better, as the bearing could be loaded to 380 pounds per square inch before seizing. This again stands to reason, as the oil holes and grooves are nearer the line of least pressure—namely, the edge of the brass. Coming now to the experiment with the oil pad touching the underside of the journal, it was seen that, with such a meagre supply as was scarcely perceptible to the touch, the journal could be loaded to 551 or even 582 pounds per square inch before seizing. This result was evidently obtained by actually getting the whole of the oil, small as the quantity was, into the bearing at the line of no pressure, or the edge of the brass, and having it thence carried round.

Finally, the experiment with the oil bath (page 223) is now mainly interesting as showing the effect, not only of the introduction of the oil at the right place, but of a more ample supply, on the reduction of friction and on the increasing of the load, the journal running in this instance with a load of 625 pounds per square inch before seizing.

It may be remarked that we have here been dealing with a bearing under constant thrust, a condition only found in single-acting engines, in car-axles, etc. In them is usually adopted a system of lubrication of the oil-bath type. This, however, is impossible in double-acting engines, with top and bottom brasses, and in these is usually found the gravitation method of Fig. 2, page 223. Better results are obtained in practice than were got in these experiments, exactly because we are not dealing with constant-thrust engines, and no bearing is so tight as to prevent the journals easing away from the top brass, on the down stroke in the case of the main bearings and on the upstroke in that of the other bearings. Thus a certain amount of oil finds its way on to the journal, and is carried round with it.

In the case of car-axle and similar journals the "dither," or vibration and end play, serve the purpose of the alternating thrust in a double-acting engine, as was proved by Professor John Goodman, who found that when a load of 1,000 pounds per square foot was suddenly brought upon a bearing it took from two to three seconds before the oil was quite squeezed out and the full friction came upon the journal. While, then, the conditions observed in these experiments are not absolutely those obtaining in practice, it is at least evident that for the efficient lubrication of a journal these conditions must be observed:

First:—The oil must be fed into the brass at the point of least pressure, which is clearly at the side of the brass.

Second:—The lubrication must be ample and continuous.

Third:—As a corollary of this second condition, the oil supply must be automatic.

How, then, are these conditions fulfilled in practice?

The common mode of lubrication, or the "gravitation method," which seeks to introduce the oil by allowing it to gravitate through a pipe from a box slightly above, or even on the top of, the bearing itself, is in its application most open to criticism. The oil duct is almost invariably led to the centre of the top brass, or to the point of greatest pressure in the bearing, serving as an escape for the oil on the pressure stroke, as may be seen by the bubbling back of the oil into the oil hole, so often noticed. Hence, of necessity, we get a restricted supply of oil—and, indeed, were it not for the alternation of the thrust, which eases the pressure from the oil hole during half the revolution, no oil would enter the brass at all. That the alternation of thrust is not in itself sufficient to allow a bearing to be efficiently lubricated is shown by the fact that experience has led engineers invariably to cut grooves from the oil hole towards the sides of the brass—that is, towards the lines of least pressure.

Plate 3 illustrates an arrangement of oil grooves proposed by Mr. John Dewrance. Here the lubricant is led into the bearing at the points of least pressure—namely, the sides—and there is no escape provided

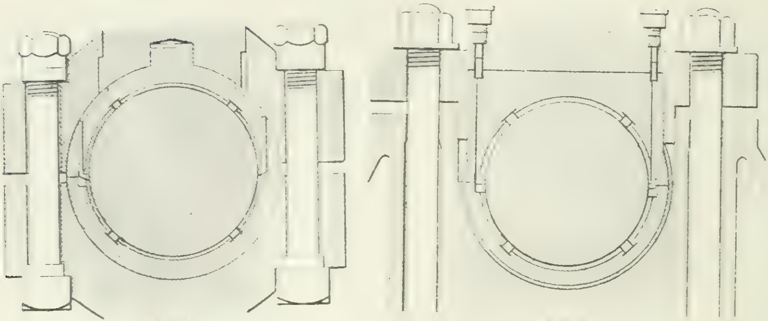


FIG. 1 FIG. 2

PLATE 3.

such as an oil hole and groove, at the point of greatest pressure—the crown of the bearing. It is, however, clearly of no avail to introduce an efficient type of oil hole and groove unless means are supplied to keep them fed with an ample and constant quantity of lubricant. For this purpose the ordinary wick syphon lubricator is almost universally fitted, but it is erratic, requires great attention, and leads to a considerable waste of oil, because, not being readily adjustable, a small bearing will often get as much oil as a large one, and the large one at times not enough, necessitating the use of the most wasteful of all lubricators—the oil can.

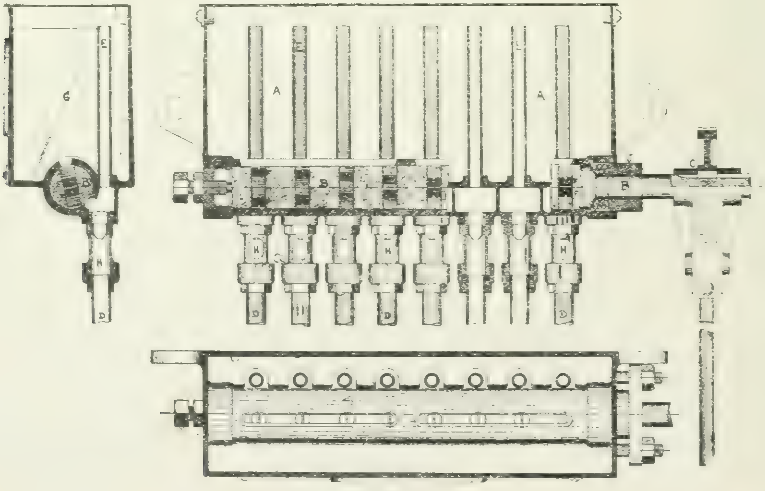


PLATE 4.

Any lubricator which permits fluctuations of oil supply cannot be regarded as good, for it either supplies too much oil when working freely, and thus is wasteful, or, on the other hand, too little, which causes, if not heating, at least an increase of friction with consequent rapid wearing of the bearings and need for repairs.

Plate 4 shows an automatic mechanical lubricator which delivers a constant quantity of oil to each bearing, which supply can be regulated by means of the plugs in the spindle and by the moveable eye on the ratchet lever, so that each bearing, whether large or small, receives no more and no less than enough oil. With this apparatus, journal friction has in many cases been so reduced as to cause a very marked improvement in the life of the bearings, and in spite of this result, an invariable saving of 25 to 50 per cent. of oil.

The following synopsis of a report of a 90-days' trial on board ship, under ordinary working conditions at sea, fully bearing out the statement that automatic lubrication is essential to highest efficiency and economy, is worthy of the attention of all engineers and owners of steam plant:

Duration of trial	90 days.
Actual steaming time	80 days.
Type of engine	Triple expansion.
Type of lubricator	"Octopus" automatic.
Bearings supplied by lubricator	Top and bottom ends of connecting rods and guides.
Saving of oil	20 per cent.
Wear and tear before using automatic lubricator	Liners were removed at every port and usually after 23 days' steaming.
Wear and tear after fitting automatic lubricator	Bearings required no adjustment after 80 days' running when ship again left port.

Two other highly efficient modes of lubrication are the splash and pressure, which, however, only lend themselves to enclosed engines. Indeed, splash lubrication is only applicable to single-acting, quick-revolution, constant-thrust engines, which have no top brasses to the crank-shaft bearings and crossheads, and no bottom working brasses to the crank pins and eccentric straps.

The lubricant, consisting of a mixture of oil and water, is put into the crank chamber, which is filled to within ¾-inch of the underside of the crank shaft. The crank pins and bottom-end brasses, the eccentrics and straps, dip into the oil at each revolution and are flooded. The main bearings, crossheads, and guides are lubricated by the oil splashed up by the cranks at each revolution. In the case of the crank-pin bearings and eccentrics, which dip into the lubricant, we have an almost exact reproduction of the very efficient oil-bath method. The departure in the case of the main bearings, crossheads, and guides would at first sight appear greater, but considering the high speed of revolution, there must be a practically continuous oil shower going on inside the casing. Therefore the difference between the oil-bath and splash method is, in this case, mainly one of name, and a high brake-efficiency in these engines is, indeed, the rule.

Forced lubrication, which is rapidly growing in favour for high-speed dynamo engines, is exemplified in the well-known Belliss engine. The crankpit forms a reservoir for the oil, which is forced, by a valveless, partially-submerged pump driven from the eccentric strap, into a main oil pipe at the back of the casing, from which branches lead directly to each main bearing. Holes drilled in the crank shaft take a supply of oil from the main bearings and conduct it to the crank-pin bearings; thence it is delivered by pipes through the interior of the crosshead pins to their brasses and to the guides. It then drains back and passes through a strainer before being again pumped into the bearings.

The pressure at which the oil is passed round the engine is from 10 to 20 pounds per square inch. While this is, of course, much less than that due to the load on the pins, it nevertheless insures the complete flooding of the brasses with a thick film of oil, as the pressure eases off the pins on the return stroke. Consequently the introduction of the lubricant at the sides of the brasses, while probably better even here—especially for crosshead pins, which do not revolve—is not so essential as with the gravitation and splash methods. Forced lubrication by this method is most efficient. Reference to the diagrams, Plate 5, bears this out in a remarkable manner.

On the diagrams are plotted the results of an official test of a Belliss self-lubricating engine. By way of comparison are shown by dotted lines the results of a trial of a single-acting splash-lubrication engine, which are useful as proving the relative merits of the different systems of oil supply. Referring to the left-hand diagram, which gives the relation of indicated horse power to the brake horse power, it is seen that in the Belliss engine with 217.8 indicated horse power the brake horse power is 209.5, giving a mechanical efficiency of no less than 96.3 per cent. At 50 indicated horse power or 45 brake horse power the efficiency is still 90 per cent. Thus, at a fourth of full power, there is maintained an efficiency as much as 40 per cent. higher than in most ordinary engines at this power. The single-acting engine shows an efficiency below 90 per cent. at full power, which falls more

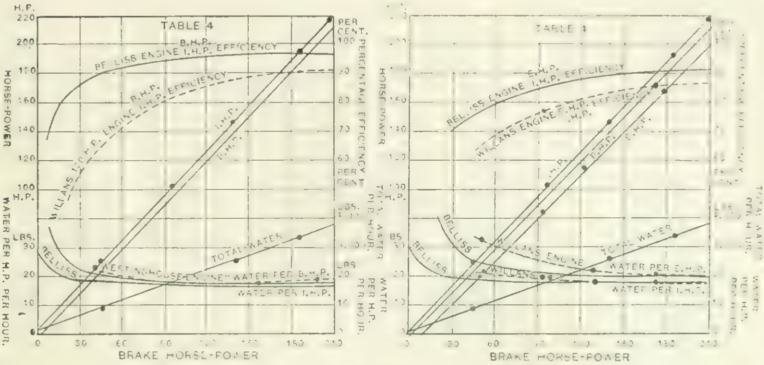


PLATE 5.

rapidly throughout, until at 45 brake horse power, which, for this engine, is more than one-third of full power, it is only 65 per cent.

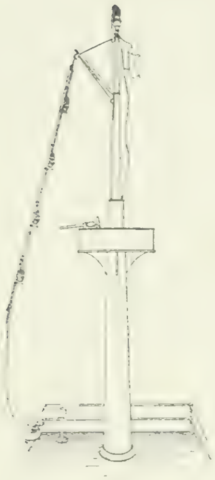
Coming now to the right hand diagram of Plate 5 the water used per indicated horse power by the splash-lubrication engine is actually less at full power than that used by the other engine, and it maintains its advantage well along the line. Turning to the water used per electrical horse power, or per horse power of output, considerable advantage is found throughout in favour of the forced-lubrication engine. It is, then, evident that the loss of economy is due to the greater friction with splash lubrication, the dynamo efficiencies being equal.

It is unfortunately usual to speak of water or steam consumption as so many pounds per indicated horse power, and the relative merits of engines are often fixed on that basis; but in doing so no account is taken of the difference of friction, which, as is shown above, may be so considerable as to render an engine, which is more economical than another in water per indicated horse power, less economical per brake horse power or per horse power of work done.

This mode of computation of an engine's efficiency and the difficulty of getting the brake horse power on marine engines, is the greatest obstacle in the path of the adaption of better systems of lubrication in the ordinary engine. Speaking generally, it is evident that the gravitation method is at present the least economical, by reason of the defective mode of fitting and the almost universal omission of an automatic oil supply. When 96.3 per cent. brake horse power efficiency, or only 3.7 per cent. less than possible mechanical efficiency, has been attained by means of a good system of oiling, it is surely unnecessary to point out to engineers and steam users the money value, not only of the increased output per pound of steam at all powers, but of the great saving in repairs.

ELECTRICAL APPARATUS IN MILITARY OPERATIONS.

By John P. Wisser.



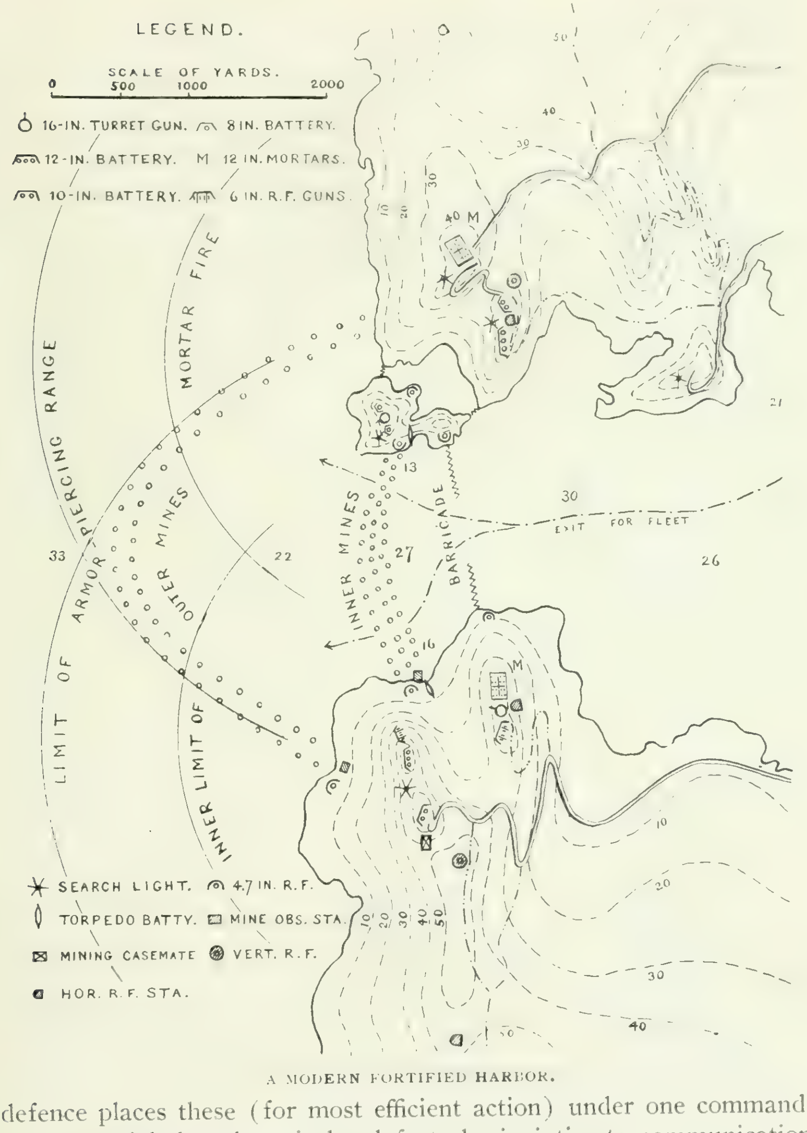
Military Mast with Ardois Lights.

THE military and naval applications of electricity have been presented and discussed from time to time for the past ten years or more, but the use made of electrical apparatus in the Transvaal war has added a new interest to the subject, and the establishment of a school for electrician sergeants in the United States army, the first of its kind, has suggested how indispensable is the electrical engineer in modern warfare. Moreover, the war with Spain gave a great impulse to the development of electrical plants in the new American coast fortifications, and the solution, by means of electrical apparatus, of ballistic problems relating to the fire of coast artillery added much valuable information for increasing the accuracy and rapidity of artillery fire, so that this appears to be an appropriate time at which to review what has been accomplished, and to indicate the lines along which electrical engineers should carry on their investigations for military applications.

The subject naturally falls under three great heads, namely, the apparatus required at permanent fortifications, that used in the field, and that needed to carry on investigations in the artillery arsenals and laboratories.

Electricity enters into all the elements of a modern fortification, for connecting the separate forts and batteries, for firing the guns, for lighting the magazines, for the signal apparatus, and for the search lights, communications, torpedoes, and range-finders. Indeed, no other branch of science has done so much to improve systems of defence, and without it our present system would not be possible. Moreover, among electrical apparatus, nothing has been so effective in economizing men and material as the storage battery.

A modern fortified harbor comprises a series of separate fortifications, often separated by water; and, since the present system of coast



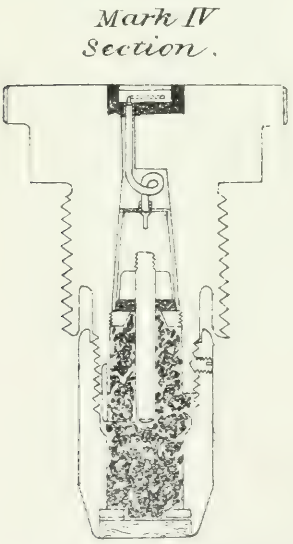
A MODERN FORTIFIED HARBOR.

defence places these (for most efficient action) under one command, it is essential that these isolated forts be in intimate communication with one another by means of cables and telephones or telegraphs, and be connected also by telegraph and telephone with range-finders in stations at the ends of a horizontal base line on the shore, and with vertical-base range-finders located at convenient points; there are also submarine mines or torpedoes in the ship channel, connected by cable with a mining casemate, search-lights to light up the channel or the torpedo-field, signal lights run by storage batteries, for signaling to friendly vessels in the harbor or to the patrol boats outside the entrance, and a complete electric plant, with engine, dynamo, storage battery, and switch-board for lighting the magazines and furnishing current for the electric firing of a group of guns or mortars.

Firing guns by electricity is largely confined to mortars and rapid-fire guns. The modern rifled mortars are arranged in groups of sixteen, in pits, behind parapets, and are aimed not individually, but all parallel to one another and with the same elevation, so that when fired in groups of eight or sixteen the projectiles fall over an area about equal to that covered by a large ship. This firing is generally accomplished by means of an electric current from a storage battery, each piece being fitted with an electric primer for firing the charge.

Rapid-fire guns (4.7 inch or 6 inch caliber) are provided with electrical firing gear, connected with an electrical pistol, fixed to the carriage, so that a man laying the gun can fire while looking over the sights by merely pulling the trigger of the pistol.

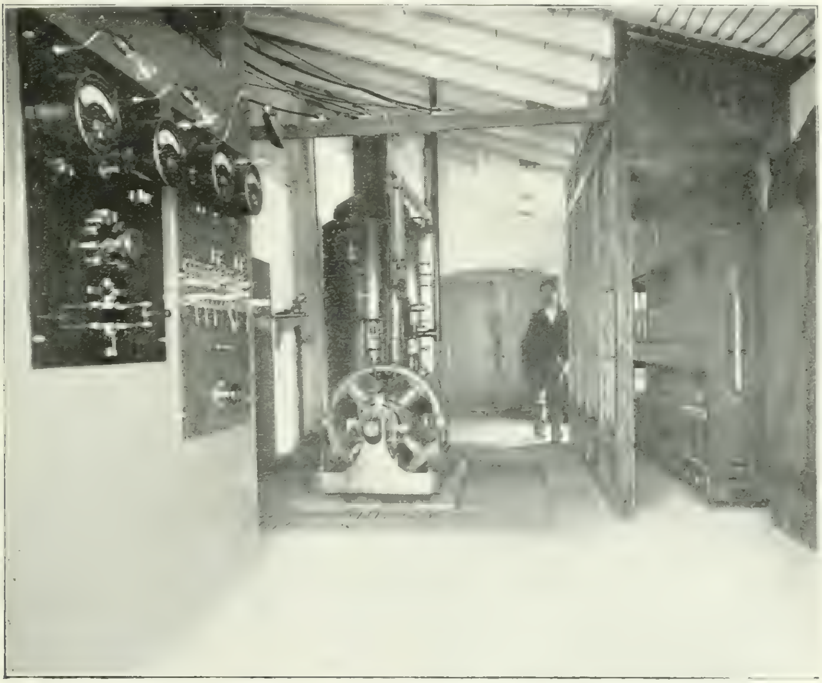
The current for firing is derived from a three-cell electrical battery placed on the carriage, one terminal connected to the pistol and the other to the carriage as an earth connection. There is also an alternative firing gear, which is used in case the first fails; it consists of a long cable, with a split pin at one end, which is pushed into a hole in the head of the firing needle, the other end being connected with the battery. In this case firing is accomplished by pushing down the end of a firing key at the middle of the cable. The great advantage of this method of firing is that the gun can be kept constantly on the target (moving ship or boat) and fired at the proper instant.



FUSE FOR 4.7 RAPID-FIRE GUN.

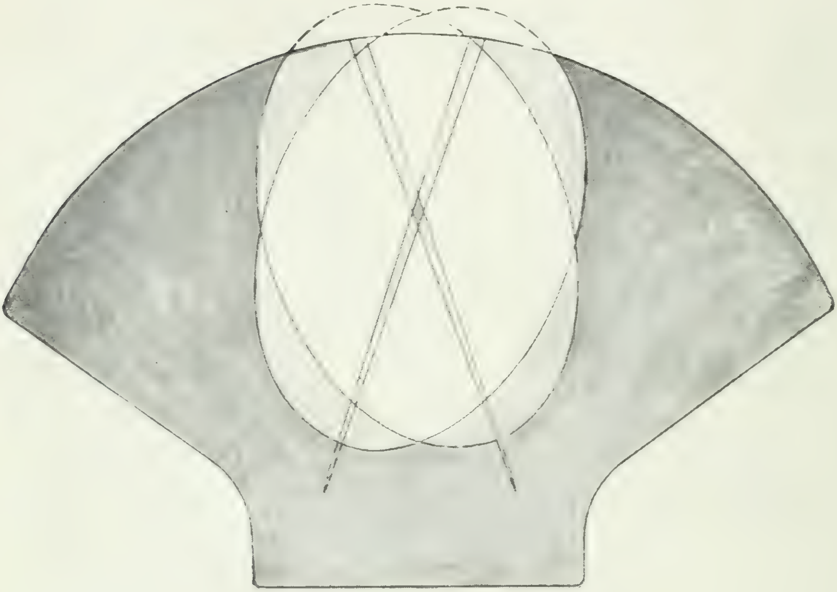
Night firing is accomplished with these guns by means of electric night sights, an arrangement for lighting up the sights of the gun by means of small electric lamps fitted with lenses, the current of three Leclanché cells being sufficient. By means of an adjustable resistance the light can be modified to suit any degree of darkness.

Range finders, to give to each battery of guns the data necessary for determining its distance to the target (any hostile ship in the harbor), are essential for guns fired, as the mortars are, without direct aim on the target, and for guns on disappearing carriages. In the United States' service, the only one involving the application of electricity in its operation is the Squier-Crehore horizontal-base range finder. Its two instruments are located in the stations at the ends of the base line, one being merely for observing, the other for both observing and plotting. The latter has two instruments, one for the plotting station proper, the other to be set parallel to the instrument at the other station. This parallelism was effected by means of an alternating current, using the principle of the Wheatstone bridge, parallelism being indicated by zero reading of a galvanometer in the circuit. This parallelism can, however, also be effected by giving the second instrument the reading of the one at the far station, sent in by telephone, without regard to the galvanometer. When the two instruments at the plotting station are properly set for the position of any hostile vessel in the harbor, the light from an



INTERIOR OF ELECTRICAL-PLANT ROOM OF A MODERN COAST BATTERY.

Engine, dynamo, storage battery, and switchboard.



SQUIER-CREHORE RANGE FINDER. SHADOW LINES.

incandescent lamp or acetylene burner in each is reflected upon the plotting table (practically a chart of the channel) forming two shadow bands (one from each instrument), which are the magnified images of a steel band in front of each condensing lens of the lamps. Their intersection marks the position of the vessel on the chart.

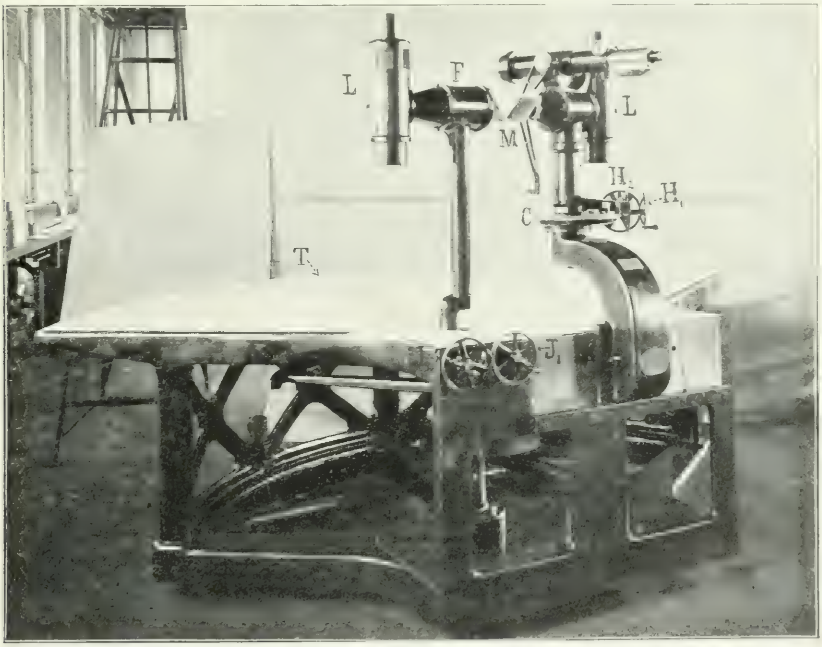
This range-finder is at present the most accurate and reliable in the United States' service. The application of the alternating current was temporarily given up by the inventors, as it was but hastily tested at the outbreak of the war with Spain, and the instrument had to be put in active service at once; but even without that it is a valuable and convenient range finder, and one was in daily use during the late war for exercising the batteries at Fort Monroe, Va.

Torpedoes come into play in coast defence in two quite distinct ways—as mobile torpedoes, fired through torpedo tubes, like those of the navy, and fixed torpedoes or submarine mines.

Mobile torpedoes are launched from shore batteries placed at points where the ship channel comes in close enough for their effective action, and their purpose is the destruction of the enemy's vessels. Many of these torpedoes involve the application of electricity, either in having their motion controlled by a current from the shore, like the dirigible torpedoes (Sims-Edison, Victoria, and Brennan), or a motor on shore is used to start the mechanism of the torpedo, and the shore connection is broken in the launching of the torpedo, as in the automobile torpedoes (Howell).

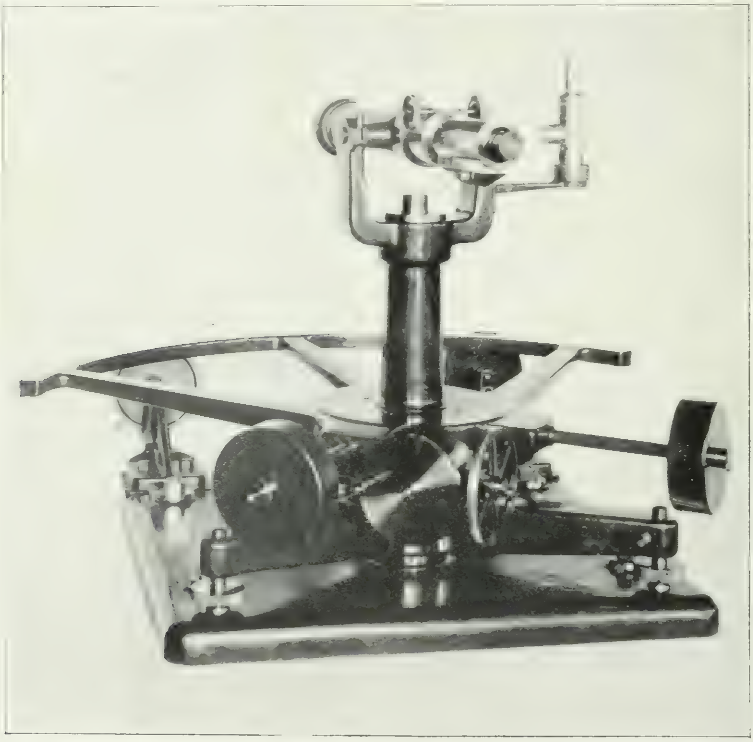
Submarine mines are used to obstruct the passage of vessels past the batteries. They are of two kinds, both electrical, viz., contact mines, exploded automatically, the electrical circuit through them being completed when a vessel comes in contact with them, and judgment mines, fired by pressing a key in the mining casemate on shore. The latter is located in some protected spot, and from it cables run out to the torpedo field. It contains storage batteries to furnish the current and a key-board for making contact in firing the judgment mines. It also has a chart of the channel, on which is indicated the position of every torpedo. For judgment firing two observing stations are also needed, so that the moment a ship arrives over any particular torpedo may be determined, and the information transmitted to the mining casemate.

Judgment mines are also contact mines, in that the striking of a ship on them closes a circuit which indicates in the mining casemate the torpedo struck, and the latter can then be exploded by pressing



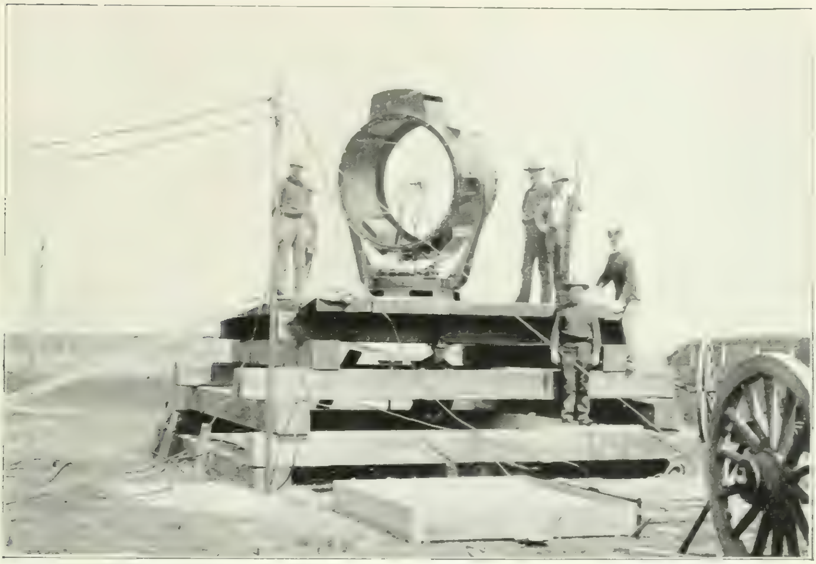
SQUIER-CREHORE RANGE FINDER. OBSERVING AND PLOTTING STATION.

the proper key. Search-lights are used for lighting up the channel at night, and especially the torpedo field, since that is particularly subject to inroads at night. They are placed at high points on the coast, not only for the service of the different batteries, but also to light up portions of the channel for the safe passage of friendly ships at night. Search-lights consist essentially of an arc light in the focus of a concave mirror, the source of the current being usually a storage battery, although in some cases engines and dynamos are used. The mirror revolves on a horizontal axis for throwing the beam far and near, and on a vertical axis for throwing it to right or left. These motions may be given by hand, but are more advantageously imparted by means of a controller, which may be placed in a safe position under cover of a parapet.



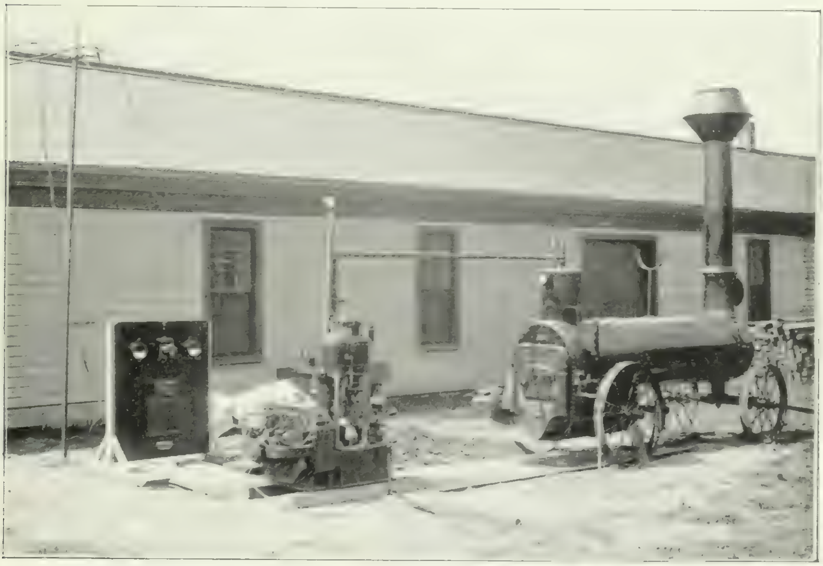
SQUIER-CREHORE RANGE FINDER. OBSERVING STATION ONLY.

The plates represent the large Schuchert search-light, with its engine, dynamo and controller, which had been on exhibition at the World's Fair in Chicago, but were installed during the Spanish-American war at Fort Monroe, Va.



MILITARY SEARCH-LIGHT FOR FIELD USE.

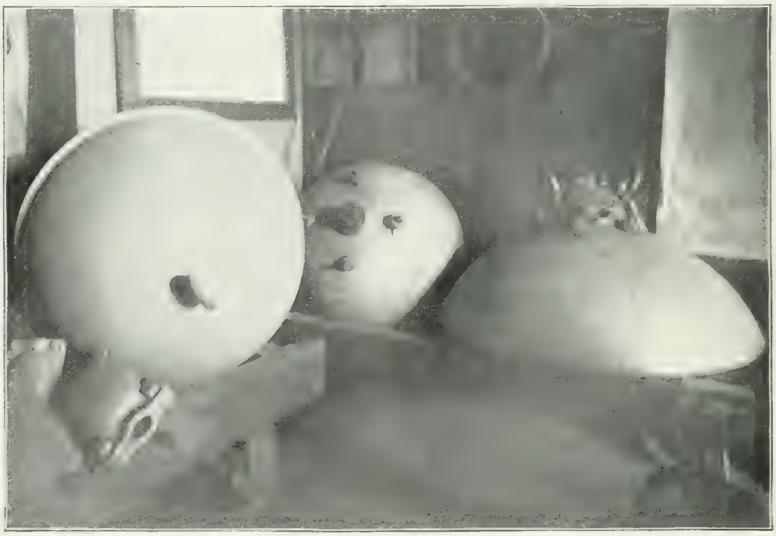
The Ardois signal light consists of four pairs of incandescent lamps with colored globes (the upper red, the lower white) fastened to a cable, suspended from the peak of a pole or mast. An electric



DYNAMO, CONTROLLER, AND TRACTION ENGINE FOR MILITARY SEARCH-LIGHT.

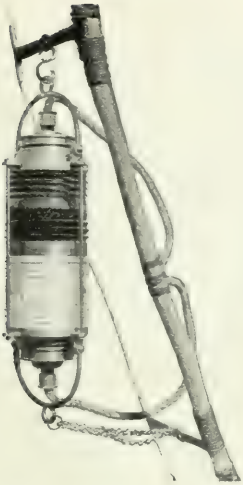
current is supplied from a storage battery, and by means of a keyboard, the keys of which are marked with the letters of the alphabet, these letters can be signaled by the lights, using the wig-wag signal alphabet, red corresponding to 1 and white to 2 in that code. Since it is in common use aboard naval vessels it is particularly convenient for communicating at night with friendly ships in the harbor, or with patrol boats patrolling the harbor.

The electric plant of a battery, or group of batteries situated close to one another, is usually contained in a separate building, and comprises an oil engine, a dynamo, a switch-board, and a storage battery. Its purpose is to furnish the light for illuminating the galleries, magazines, and store-rooms of the emplacement, and, if necessary, to furnish the voltage for firing the guns by electricity. The great advantage of the storage battery for military use is its economy in men. One man can easily take care of the entire plant of a battery, and he is hard at work only one day in the week, when he is charging the storage battery; the rest of the time is at his disposal for keeping his apparatus in order, and for attending to the switch, when necessary.



SUBMARINE MINES, TO BE FIRED ELECTRICALLY.

Several complete systems of communication are required in every permanent fortification. The means now generally used is the telephone, but if that fail the telegraph can readily be substituted. In the first place, there must be such a system that the fort commander can go to some central station (as one of the range finder stations) and



METHOD OF SUSPENDING LANTERN.

(By courtesy of the General Electric Co.)

send orders to any other station or to any battery of the fort, without interfering with the regular transmission of the data from the range finders. This requires a separate line and a separate telephone in each station and battery, including search-light, signal light, etc. In the next place, each range-finder must have an independent line to the batteries which it is intended to furnish with data and information. Then there must be in addition a system connecting the observation stations for the torpedo service with the mining casemate. These lines are now generally underground cables, the overhead wires being too readily destroyed by the enemy's fire.

Electricity, therefore, pervades every nook and corner of a modern fortification, and at every turn electrical engineers are in requisition. This has been so keenly felt by the military authorities that electrician sergeants are now a part of the non-commissioned staff of every fort in the United States, and a school for the instruction of candidates for this grade has recently been established at Fort Monroe, Va., and already numbers some thirty students.

There are two great desiderata in the equipment of a fortification, toward which efforts at invention and improvement should be directed—a durable and reliable dry cell for use in firing rapid-fire guns electrically, and a quick system for converting the data obtained by the range finder and transmitting them to the gunner in the form of range from his piece.

THE ARDOIS KEYBOARD.

(By courtesy of the General Electric Co.)

IN THE FIELD.

The applications of electricity in the field are far more limited than in permanent fortifications, but in their effect on the operations they are of immense importance. Until quite recently the only application of any importance was the field telegraph or telephone, but to these must now be added wireless telegraphy, search-lights, and automobiles.

The development of the field telegraph is an interesting example of the use made by the science of war of progress in the other sciences; but aside from that it illustrates also the fact that it has a little realm of progress all its own, in which the requirements of the service demand new adaptations of principles long known.

The first material (following that used in civil life) consisted of bare copper wire on poles, but the train required to transport the material limited its application very much, and efforts were made to lighten it, especially as regards the poles. Then it was proposed to use insulated wire and lay it directly on the ground, but it was soon found that this was too liable to destruction by the troops on either side, and for a time this method was abandoned. Indeed, it required the experience of two wars (1870 and 1878) to convince the two nations, Germany and Russia, that in order to use bare wire on poles in the field it was necessary to educate the soldier by annual peace manœuvres to appreciate the necessity for keeping intact his own army's communications; he found the poles useful for fire-wood, and applied the wire to many useful purposes other than that for which it was intended. The insulated wire, however, was finally adopted, but in the form of a cable, the conducting wires of copper being strengthened by means of one or more strands of steel wire.

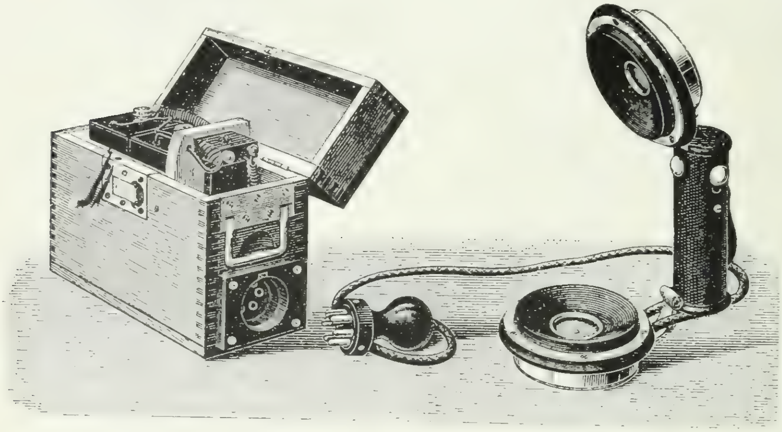
The English (1888) field cable has one steel wire and six copper wires; its diameter is 0.22 inch, its weight 169 pounds per mile, and the ratio of its tensile strength to its weight is 2.56; while the latest German (Siemens) cable has seventeen steel and three copper strands, with a diameter of only 0.13 inch, a weight of only 77 pounds per mile, and a ratio of tensile strength to weight of 7.37.

These improvements allowed of small, light wagons for transporting the material, and the latter could be unrolled directly from the wagons, so that the mobility and rapidity of laying were immensely increased and the telegraph could be carried to the front line of the main body of the army in the field.

But efforts at improvement were continued with a view to carrying the telegraph into the outposts, and the first step in this direction

CONSTRUCTION OF A MILITARY TELEGRAPH.
Train erecting line from Puerto Principe to Nuevitas, Cuba.

was made by the introduction of the Buchholtz outpost cable, of the same diameter as the Siemens field telegraph, but lighter in weight. Its ratio of strength to weight (2.38) was, however, too low, so improvements were started in an entirely new direction, by giving up the cable altogether, in this zone of the field of operations, and using a bare wire laid on the ground with but slight ground connection, adding the Cardew sounder (first used in the Egyptian campaign of 1882), in which the extra currents of self-induction are used, a telephone acting as receiver. The Austrian cavalry patrol apparatus, ten years ago the best in use, was so light that it could easily be carried by a single trooper. The wire is very fine, the entire roll of 540 yards weighing only a little more than half a pound. The later German apparatus (1897) is a further improvement, and in its present state meets all the demands for its full application in all positions on the field of battle, even to an outpost or patrol composed of a single soldier.

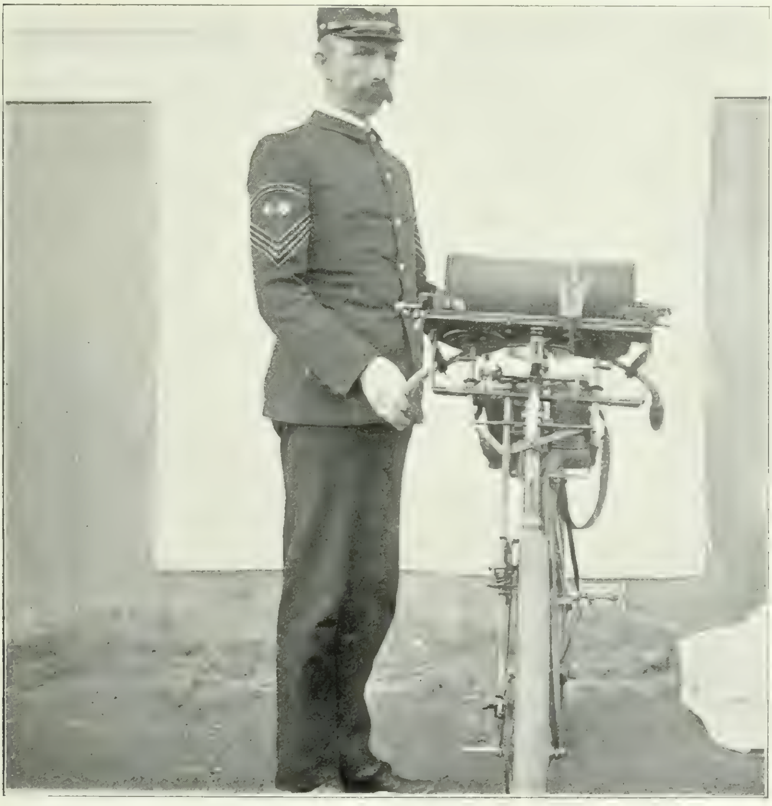


SIEMENS-HALSKE FIELD TELEPHONE EQUIPMENT.

The telegraph still has the great advantage over the telephone in its much greater certainty of action under the various conditions liable to arise in war. Nevertheless, the other advantages of the telephone are so forcible that it will certainly be used as long as it can be, and wherever it is possible to find employment for it practically. Hitherto, the bulk and weight of the necessary apparatus have interfered greatly with its field use, and this difficulty has been due mainly to the call bell. Moreover, the time that would be lost in taking out the telephones of a field line in case they failed, and putting in the telegraph, combined with its less certainty of action, have militated against its extended field use at the front.

Late improvements, however, have overcome some of these disadvantages by so combining in the same apparatus a telegraph instrument with a telephone that a mere turn of a switch will throw in or out one or the other, and by introducing a reliable call bell. The instrument now used in the German army is that of Siemens & Halske, the entire outfit for which is contained in a wooden battery chest and a leather telephone case, the whole weighing about nine pounds. The battery chest contains a battery of two dry cells, the switch and key, and an induction coil, with primary, secondary, and tertiary coils; the telephone case contains the telephone and the microphone or buzzer. A turn of the switch and the depressing of the circuit closer puts the instrument in condition for calling or for telegraphing, the circuit, through the induction coil and microphone, being completed by a key. When the key is depressed the current from the battery, through the primary, causes rapidly alternating induced currents in the microphone, which are reproduced in the secondary, producing a buzzing in the telephone receiver at the corresponding station. By turning the switch in the opposite direction and leaving the key open the electro-magnet is cut out and the circuit is an ordinary telephone circuit with the microphone as receiver.

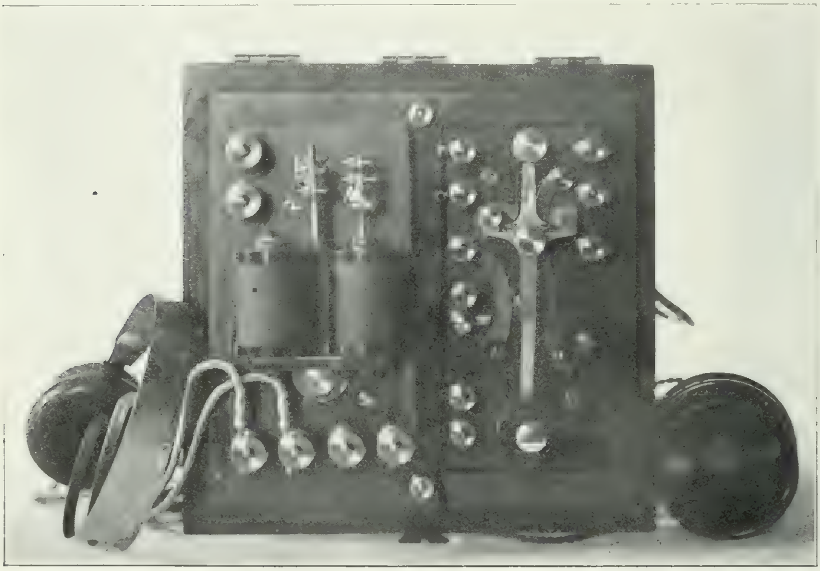
A similar apparatus is in use by the United States Army Signal Corps in the Philippines, the field outfit being contained in a box of about nine cubic inches volume. The wire used for telephone connections at the outposts is No. 22 copper, carried on a portable reel.



FIELD TELEGRAPH EQUIPMENT. A BICYCLE REEL.

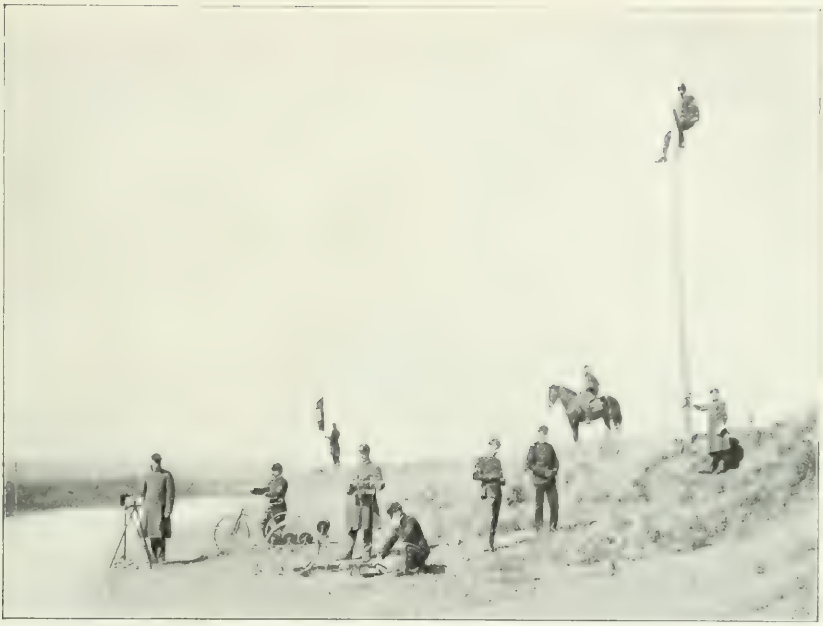
This wire can be used naked, and has been so used over a line thirty miles long; but for safety, and in rear of the outposts, where rapidity of laying and portability are not such essential qualities, cables composed of a central wire of copper surrounded by six steel strands are employed, and the whole is insulated with pure rubber.

The telegraph and telephone work of the Signal Corps in the Philippines has exceeded any previous record of military telegraphy, and its enormous work may be illustrated by the fact that in the extensive field operations during last January an average of five thousand messages per day were sent.



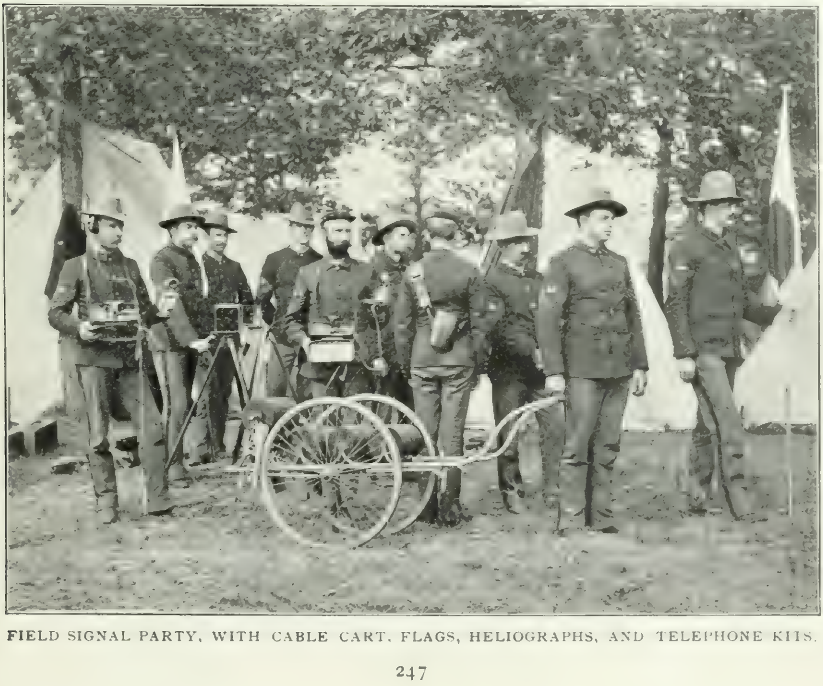
TOP OF "TYPE B" U. S. FIELD TELEPHONE-TELEGRAPH APPARATUS.

Before the war of 1870-71, optical telegraphy comprised signaling by means of flags by day, and by means of lanterns or torches by night; but in that war the heliograph proved its efficiency, especially in maintaining for a long time good communication between Mount Valerian and Versailles, so it was generally adopted. The electric light was at once suggested to make the system independent of sunshine and fair weather, but the difficulty of having it on hand in the field was then too great, so other sources of light (such as improved petroleum lamps), were used for a time, and the army telegraph trains of France, Austria, Italy, and Denmark were fitted out with apparatus of this kind. England, however, adhered to the heliograph,



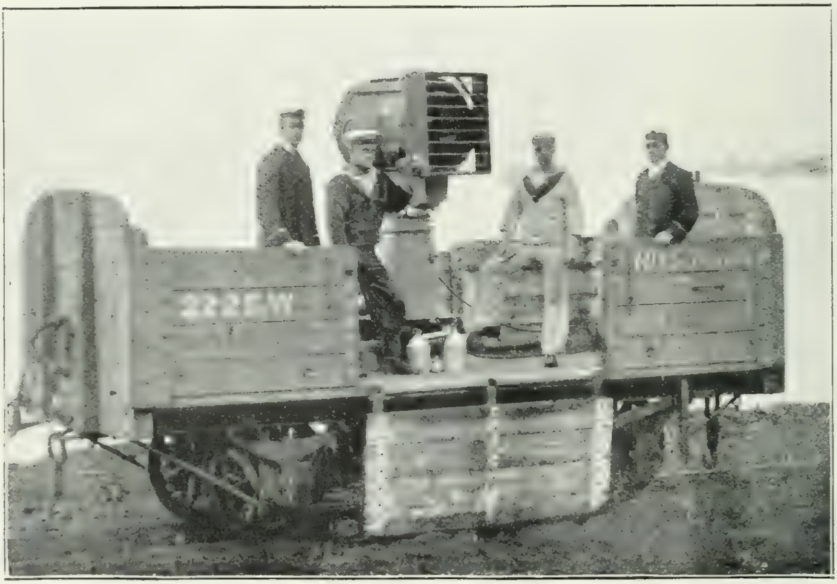
MILITARY OUTPOST CABLE CONSTRUCTION.

The operator, kneeling on the ground, is telephoning to headquarters. The machine in front of him is for letting out and taking up insulated wire.



FIELD SIGNAL PARTY, WITH CABLE CART, FLAGS, HELIOGRAPHS, AND TELEPHONE KITS.

and had great success in its use in India and in South Africa, in some cases for distances of more than one hundred miles. Ordinarily, however, the heliograph, using as it does the sun's rays as the source of light, is limited to a range of about fifty-five miles; but by means of relay stations it can, of course, be used to much greater distances.

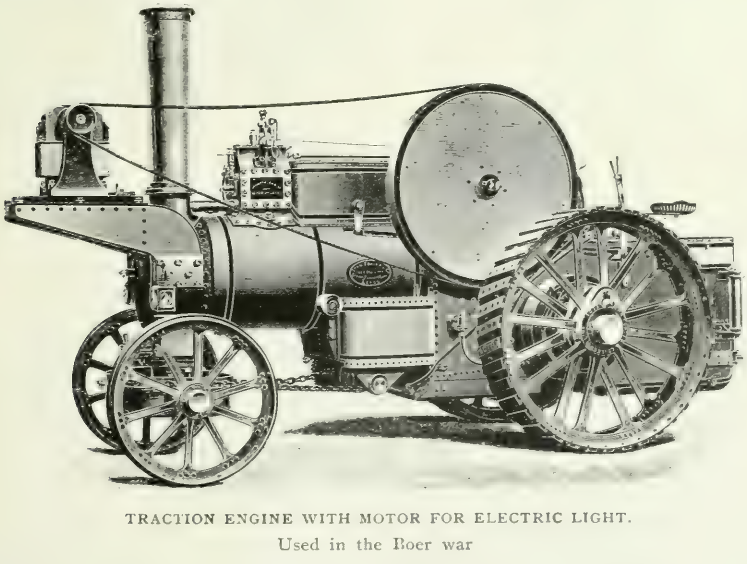


SEARCH-LIGHT ON RAILWAY TRUCK, TRANSVAAL WAR.

However, in the field such relay stations are liable to interruption by the enemy's cavalry, the messages can often be intercepted at certain points by interposing a cloud of smoke made by burning brush or damp straw, and, finally, the number of repetitions required not only delays the message but also increases the chances of error. The electric-arc light is far more efficient than the reflected rays of the sun, and is also independent of the weather and can be used by night as well as by day. By its means the range has been extended to more than four hundred miles. In the Transvaal war the British made use for this purpose of the electric search-lights from the ships, and this was, indeed, the only means of communication with the external world relied upon by the besieged garrisons of Ladysmith and Kimberley. The traction engines, which the British used so extensively in the Boer war, are also provided with search-lights, which are run by dynamos driven by the engines.

The Austrian field train is provided with a portable search-light transported on three wagons, its parabolic projector having a diameter of nearly three feet. Würtemburg has in its field train a single wagon for this purpose, containing a 5 horse-power petroleum motor and a dynamo furnishing a current of 65 volts 40 ampères, the entire wagon complete weighing only 4,500 pounds, and therefore being capable of going over any kind of road. The search-light wagons of Switzerland and Germany are somewhat heavier, and are intended for use in fortifications or along the coast.

The system of wireless telegraphy, as Professor Trowbridge of Harvard University tells us, "is emphatically a spark system strangely analogous to flash-light signaling, a system in which the human eye with its rods and cones in the retina acts as the coherer, and the nerve system, the local battery, making a signal or sensation in the brain. Indeed, there is a close parallelism between the search-light and the spark used in Marconi's experiments: both send out waves which differ only in length." The magnetic waves of the spark are more than a million times longer than the light waves, and are able to penetrate fog, and even sand hills and masonry. Wireless telegraphy will probably find its most important application in the navy, but will also be useful between the isolated forts or stations of a harbor, when other communications are interrupted, and in communicating with beleaguered garrisons. Secret wireless telegraphy is not yet a solved problem. The

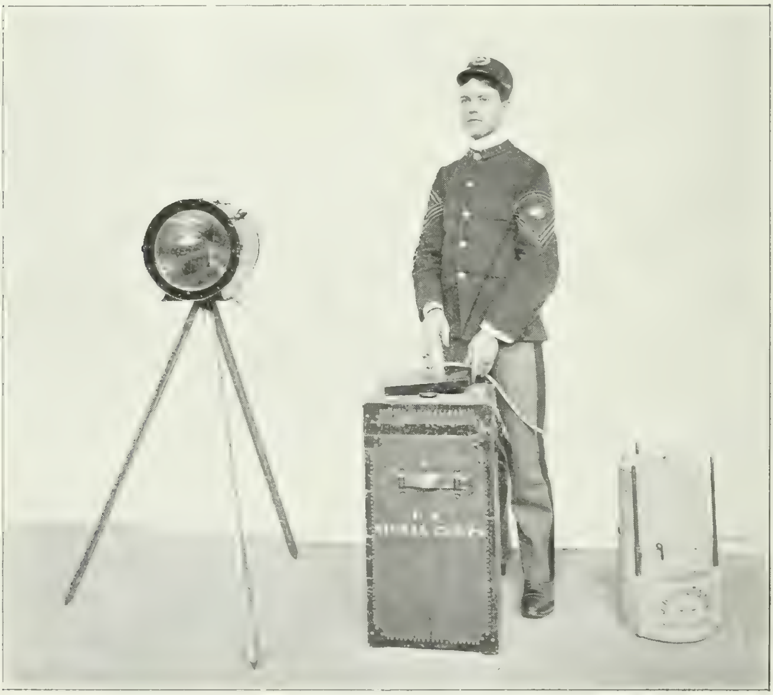


TRACTION ENGINE WITH MOTOR FOR ELECTRIC LIGHT.
Used in the Boer war

message spreads out from the sending spark in circular ripples in all directions, and may be received by anyone; it will be necessary first to invent a receiver which will properly respond to a definite number only of the impulses sent out.

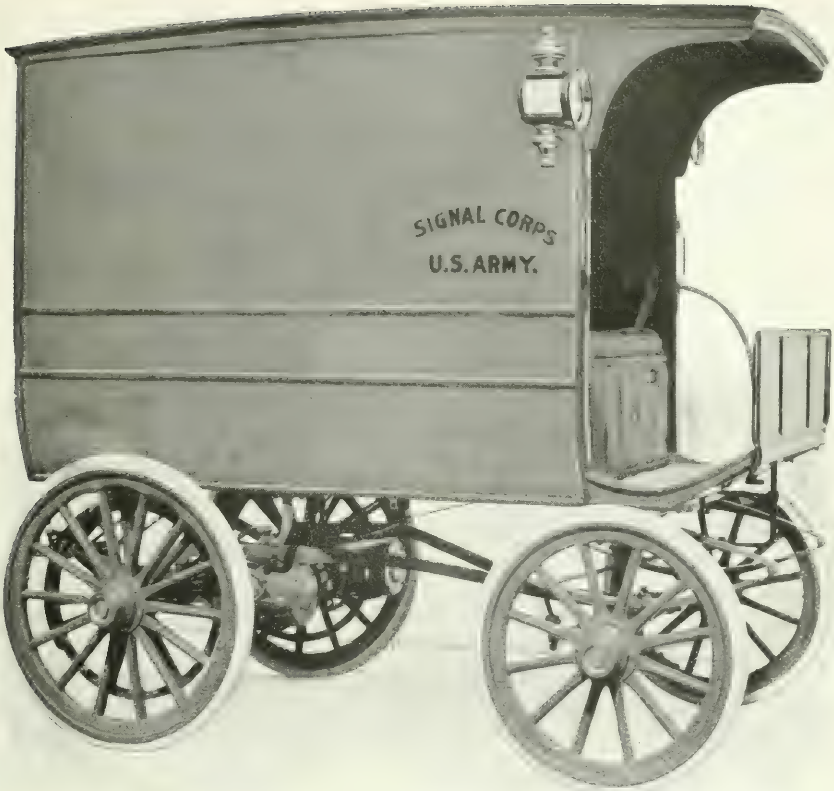
Experiments are being conducted, however, in nearly all countries, to test its utility for military use, and during the past month the garrison of Antwerp, in Belgium, was assembled to witness the action of the apparatus between different parts of the fortifications.

England sent to the Transvaal last December a section of telegraphers, supplied with a number of wireless-telegraphy stations, to practice this system in the field. It was used successfully to communicate with the besieged garrison of Ladysmith. Some of the stations (to obtain greater height of vertical wire) were established in balloons. Definite reports of the work are, however, not yet available.

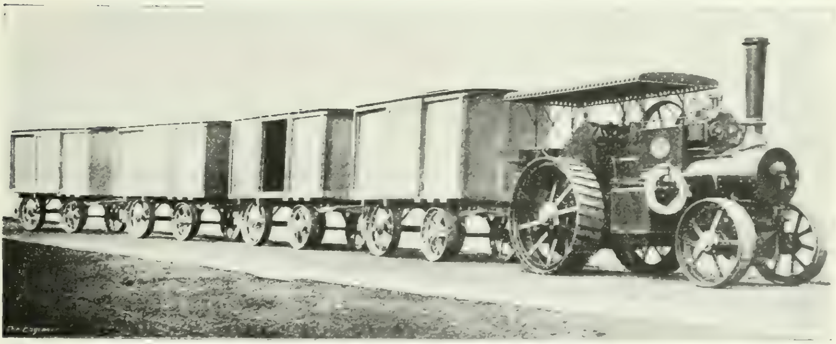


NIGHT SIGNALING WITH ACETYLENE LIGHT.

The question of the application of motor wagons for purposes of transportation in the field army has attracted marked attention from all the principal nations, but the experiments in Germany and Italy have



U. S. SIGNAL CORPS AUTOMOBILE MILITARY WAGON.



TRACTION ENGINE USED IN THE BOER WAR.

thus far been unfavorable to their selection for this purpose, the preference being given to traction engines. The two systems may be thus compared:

Ten automobile wagons of normal type, weighing 30 tons (12 of which are useful load), can cover daily a distance of 47 miles, the length of train column being 195 yards; whereas, a traction engine, with tender and two-wheeled wagons, weighing in all 30 tons (12 of which are useful load), can cover daily the same distance, the length of train column being only 110 yards. Moreover, in the first case there are ten pieces of apparatus to get out of order, in the second only one.

Nevertheless, automobile wagons have been introduced in several armies. England, for example, has two types—one an armored observation car, built for use in the operations in Egypt, to run on the railroad tracks there, capable of carrying a Maxim gun, two officers and one man; the other, for ordinary roads, also armored, and carrying two Maxim guns and a dynamo to supply a current for a search-light, which current can also be turned into the steel blinds (closing the doors and windows) in such a way so to give an electric shock to an enemy boarding the wagon. In both types the power is derived from a benzine motor with electric ignition. The Signal Corps of the United States Army has also adopted two electromobiles, one for transporting the officers, the other for carrying the men and materials. There are two 3½-horse-power motors (one under each rear wheel), run by storage batteries, one charge being sufficient for 30 miles when carrying 1,500 pounds' transportation load. The tires are solid hard rubber, and the maximum speed of the wagons is ten miles an hour. They are fitted with electric lights externally and internally, and a new form of search-light is to be added.

Balloons.—The application of electricity to balloons is, of course, secondary in character. The fixed (anchored) balloons (spherical or sausage-shaped) have no electrical appliances in themselves, although they may carry electrical instruments for telegraph, telephone, or wireless-telegraphy work. But some of the forms of dirigible balloons involve electricity either in their electric motors or in the electric ignition of their benzine motors. One of the latest forms involving the latter is the great balloon of Count Von Zeppelin, just completed at Stuttgart, Germany, which is to make its trial trip on the first favorable opportunity. It is 135 yards long, 13 yards in diameter, and its cubic contents are about 12,000 cubic yards, while its weight is about the load of an ordinary railway car. Its motive power is derived from two benzine motors (with electric ignition), located in the two boats under-

U. S. MILITARY BALLOON GENERAL MYER.

neath the main body of the balloon, which set in motion four symmetrically disposed screw propellers, 1 yard in diameter. The action of the screws was tried by placing them (above water) in a small launch, and it was found that the launch was moved through the water by these aerial screws at a rate of more than 8 knots, so that there can be no question as to their action on a balloon moving in air. The entire frame-work of the balloon is of aluminum and it is covered with pegamoid linen cloth.

Its conception and construction are regarded as the most important step in aeronautics since the discovery of the balloon, and its trial will be watched with great interest, especially by the military world, which has long been striving to perfect a dirigible balloon.

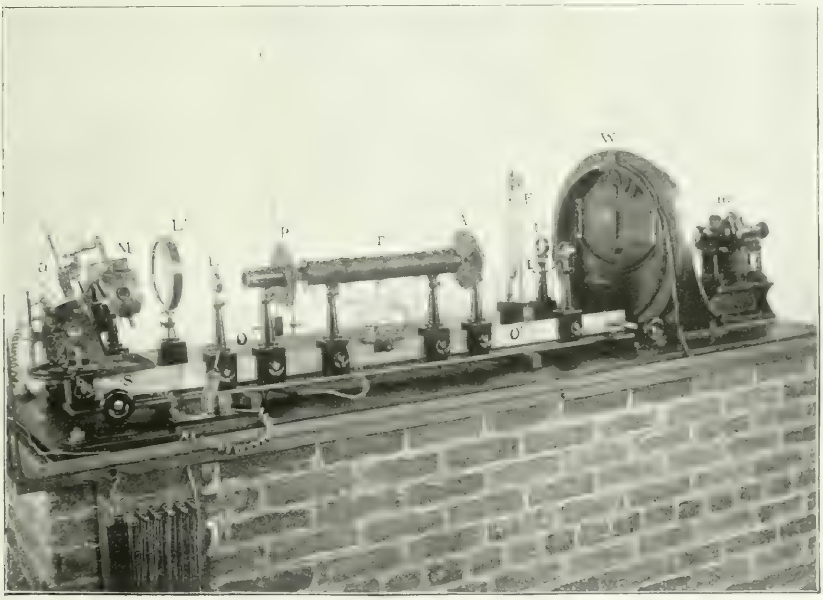
All the great nations of the world have recognized the necessity for carrying on investigations in the subject of ballistics, in order intelligently to meet and solve the great problems of artillery constantly rising. These investigations are carried on at the artillery arsenals. many of which, like those of Woolwich, Vienna, Spandau, Cherbourg. and Toulon, have become famous. The United States laboratory at the Artillery School at Fort Monroe, Va., has done much to further the science of artillery, for there Captain Zalinsky began the experiments which led to his dynamite gun, there Captain Lorain made the first telescopic sight used by the United States artillery, and there Professor Crehore and Lieutenant Squier constructed their chronograph and their range finder.

Nearly all of these investigations depend upon electrical apparatus, because they necessarily involve accurate measurements, especially of small intervals of time. The commonest problem is the determination of the velocity of projectiles, and for this purpose the Le Boulengé chronograph was long used—indeed, up to a very few years ago it was practically the only instrument in general use for this purpose, and it is still used for rough work. For accurate work, however, it is being rapidly displaced. In England the Smith chronoscope has been adopted in all the artillery laboratories, and in the United States the Crehore-Squier polarizing chronoscope has been installed in the electrical laboratory at the Artillery School.

The last-mentioned is in many respects an entirely new physical-laboratory apparatus, in which Faraday's discovery, that a magnetic field will rotate the plane of polarization of light, is applied to produce a camera shutter *without mass.*

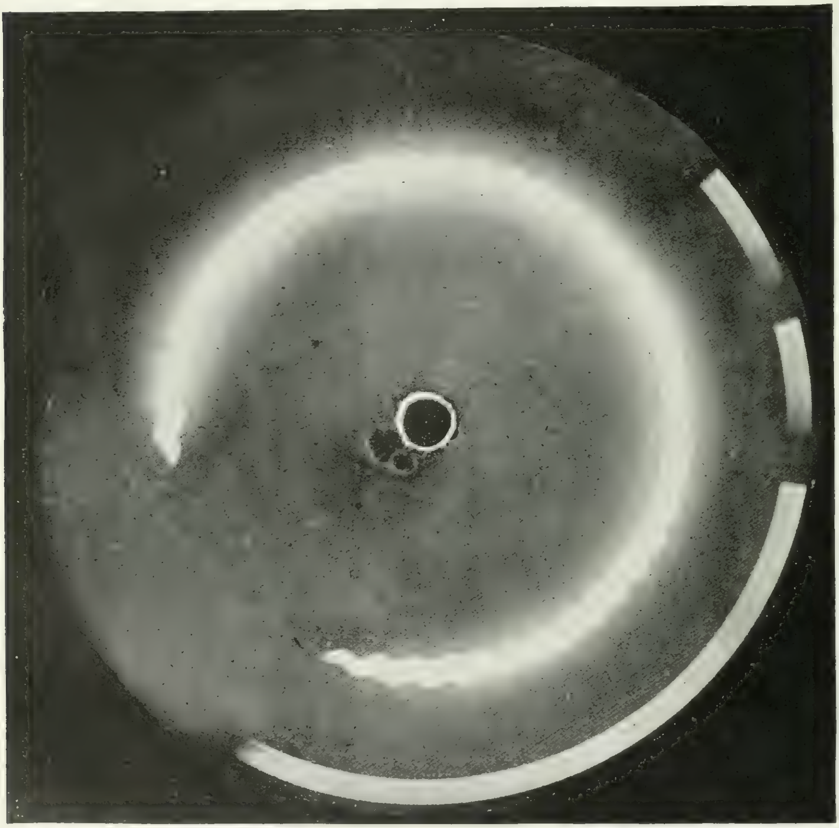
The apparatus, resting on inverted T rails, O and O′, (traveling on rails V V′, moved independently by screws S S), firmly set on a pier, comprises an arc lamp *a,* and condensing lens L, the polarizer (a Nicol prism) P, the coil T (inclosing a tube filled with carbon bisulphide), the analyzer A (another Nicol prism) and the lens L′; the mirror M (which reflects the light from the arc lamp), a condensing lens L″, the tuning-fork F (which has a little piece of aluminum foil, perforated by a small hole, attached to one prong), and the magnifying lens L‴. The heavy cast-iron fly-wheel W, rotated by a small motor *m,* has mounted in it a plate holder, the sensitized plate of which, rotating with the wheel, acts as a receiver. The gravity switch U is merely a weight falling so as to make in succession two contacts, the first causing the material shutter of the camera to drop and expose the plate, the other starting the motion which we desire to measure.

To conduct an experiment the lamp current is started, the polarizer and analyzer are set so as to produce darkness at the focus of the lens L′, a current is sent through the coil of the tube T, and in the passage of the beam of light through the carbon bisulphide (which is evidently in a magnetic field so long as the current passes through the coil) its plane of polarization is rotated through a certain angle, and light emerges from the analyzer; the motor is then made to rotate the plate, the fork is set vibrating, and the weight on the gravity switch is dropped. The dropping of the material shutter of the camera exposes the plate at a radial slit, which admits the light for the chronograph record, and also at a round opening, through which the light from the tuning-fork passes. The moving body (a projectile fired from a gun) is made to break the circuit at a series of wire screens arranged in succession in its path, contact being made automatically after each break. Now, whenever the current is broken the carbon bisulphide, being no longer in a magnetic field, loses its rotary power, and hence there is darkness, or a break in the chronograph record—in other words, the massless shutter has fallen and shut out the light; as soon as the circuit is closed again the massless shutter is opened and the light let in, and



SQUIER-CREHORE PHOTO-CHRONOGRAPH.

so on. The tuning fork record of the light through the aluminum strip on the fork is continuous, and serves as the time scale, the number of vibrations between breaks being measured by counting the waves, and, as the rate of the fork is known, the time interval between breaks is readily determined. With this instrument the velocity of a projectile was measured at seven consecutive points inside the bore of a field gun.



CREHORE-SQUIER CHRONOGRAPH RECORD PLATE.

The necessity for electrical apparatus in all the departments of military science is therefore apparent, and a knowledge of electricity and its appliances is essential to-day, not only for the officer but also for the private soldier. Moreover, the field for the electrical engineer is continually widening, for, although the army is striving to make itself independent by educating its own men to take care of the necessary military apparatus, the science of electricity is continually invading the domain of military science through new passages, so that much of the work necessarily remains for the electrical engineer.

EDITORIAL COMMENT

According to appearances as we go to press, no Isthmian-Canal bill will be passed by the United States Congress at this session. The immediate reason seems to be parliamentary, but it is greatly to be hoped that back of that lies a reaction to sober sense and an appreciation of the impropriety and folly of acting in so important a matter without a knowledge of the facts.

Before the matter comes up again the report of the Commission who have been studying the entire isthmus should be ready and available. The work, with the exception of some surveys on the ground, is substantially completed and the Commissioners have returned, but Admiral Walker very properly declines to anticipate in any way the drift of their conclusions, or to make any statement except that the Panama and Nicaragua routes have been thoroughly examined, and in addition, especially, the Atrato route—of which, by the way, a complete and exhaustive survey was made many years ago by John C. Trautwine, Sr. Admiral Walker says that the merits of each route have been fully recognised and the difficulties of each accurately weighed. For the nett result we must await the report.

Meanwhile, factionists are sedulously cultivating the popular impression that "Isthmian Canal" and "Nicaragua Canal" are synonymous expressions, although in other quarters it is hinted that Atrato may prove the "dark horse." May the best route win!

* * *

It would be a curious turn in politico-economical affairs if it should prove that Russia, in opening up Eastern Siberia and Manchuria by railway and telegraph, had been creating markets and engineering opportunities for the United States to seize. There are many suggestions, however, that this is not far from an accurate summary of the situation, and some patriotic Russians are disturbed over it, though it would seem as if Russia were not yet sufficiently self-supplying, as to her European territory, to do else than rely on outside producing countries for the development of her vast Pacific possessions.

Two things have probably combined to turn the attention of the United States toward this region—first, the Russian quest for railway materials for her Eastern lines, which have resulted in large shipments to Vladivostok from the Pacific Coast; second, the coincident direction of the attention of American manufacturers to the "Far-Eastern" markets, following the acquisition of the Philippines.

The expansion of Trans-Pacific commerce is destined to be one of the great features of the next few decades. Already it is foreshadowed in the huge fleet for the building of which James J. Hill is making plans and contracts. And in the creation and control of this commerce Japan, according to well-informed observers, is going to be a leading factor. We shall have more to say on this topic shortly in an illustrated article by Mr. A. H. Ford, who has lately returned from an extended tour of investigation and study of the Trans-Siberian and Chinese Eastern Railways.

* * *

In all discussions of cable routes across the Pacific it seems difficult to get rid of the idea that the military features are paramount, and that national control is of vastly more importance than questions of construction, operation, commercial value, and general feasibility put together. At the same time, it might be observed that no one factor is more powerful in conserving the peaceful relations between nations than close commercial connection, and when industrial, manufacturing, and business relations are closely interwoven, political differences are very likely to be settled without recourse to the last resort of arms

In the able discussion of the northern route between the extreme northwestern coast of the United States and the Philippine Islands, which was published in the issue of this Magazine for November last, it was pointed out that the shortest, or great circle, route possesses every advantage which could be desired. The distance is the shortest possible line between America and Japan, and hence to the terminus of the Trans-Siberian Railway; it is divided into a number of moderate stretches of nearly equal length and uniform depth; the line starts near the latitude of Paris and its highest point north is in the latitude of Aberdeen. The lowest temperature ever recorded at the northernmost point is 15° C. below freezing, and none of the landing places is troubled with ice, teredo, or coral. In short, the route is the ideal one for cable communication between America and Asia, and its construction would provide an international system, open to all nations, and hence not to be interrupted by any—a system built for the ends of peace, commerce, and industry, and by the furtherence of those ends one which would become a powerful factor in preventing war and the necessity for a military means of communication.

While such considerations may not appeal to those whose interests are bound up in matters military, yet they should appeal to the men who, above all others, have done the most to advance civilisation and progress—to the engineer, the manufacturer, the industrial manager of great enterprises; and it was to such that the northern route, from its inception, was expected to appeal.

* * *

One of the regular accompaniments of the international exposition of the present day is the series of congresses upon various branches of systematised knowledge, which has been found of increasing value with every succeeding gathering. In all such congresses the gatherings of engineers have proved of importance, not so much for the direct and immediate results which have followed as because of the broadening influence which is exerted upon the work of the profession at large.

Specialisation is undoubtedly the order of the day in engineering, as in other professions; but yet it is a well-known fact that many great advances in the arts have been made by those whose regular occupation is foreign to the subject in which success has been attained. This is but the natural result of too close application to the limited field of the specialist, which gradually gets the worker into a groove of ever increasing depth, from which he finds it more and more difficult to climb. A meeting with fellow-workers in allied branches, however, invariably acts to broaden the field of view, and a congress at an international exposition is still more effective in preventing the excessive conservatism which is fatal to all real progress.

It will be a matter of interest to watch the outcome of the extensive series of congresses upon engineering and other scientific subjects which are to be held in connection with the Paris Exposition, and to compare the immediate with the ultimate effects.

That many important and valuable papers will be presented and discussed is to be expected, but it may well be asserted that the broadest influences which will result are those which will not be recorded in the transactions nor published in the technical press—the influences which will pass from man to man, from specialist to specialist, showing each the immense field outside his own necessarily limited area, and stimulating him to better, truer, and more effective work within the range which he has mastered.

International expositions are primarily supposed to be held for the direct advance of commerce, trade, manufactures, and all that is included in the advertising character of exhibits and display; but it is now generally admitted that the effect which they have upon general development of social and intellectual progress is an equal function, and one which may ultimately overshadow the material features to an ever increasing extent.

* * *

The final acceptance of the Holland submarine boat by the United States Government, and the probability that a number of others will be constructed, gives some reasonable assurance that a fairly satisfactory solution of the problem has been attained, at least within reasonable limitations. There is no doubt that the trials were made as stringent and searching as the conditions would permit, and that. had the boat not responded to the requirements in a satisfactory manner, it would not have been accepted.

Under these circumstances it seems probable that in the next conflict between naval powers the submarine boat will have to be reckoned with as one of the unknown factors in the problem, which means that the hold of the engineer upon naval warfare is to be made stronger than ever in the immediate future. It cannot for a moment be supposed that the use of such vessels will be limited to any one nation. France has already been experimenting with them, and has reached a point where practical success seems assured, and England will not be long behind ; and with the experience which will come from practice in manœuvring and control, a new series of tactics will be evolved which, for harbour defence at least, must modify very greatly the accepted methods. THE ENGINEERING MAGAZINE will shortly present a comprehensive review of the submarine boat by Admiral Hichborn, Chief Constructor U. S. N.

It has been suggested that it is not only for harbour defence that the submarine boat is adapted, since small boats of this kind might be carried, like large torpedoes, upon cruisers or swift consorts, and launched only when within practicable working radius of the enemy. Here again it is the engineer who will have to stand the brunt of the battle, and sealed up in the automobile torpedo, with every risk of disaster and death from an invisible enemy, he will decide the fate of battles and of nations.

It has generally been argued that the development of destructive methods must ultimately result in the abandonment of warfare, and the argument is doubtless correct. The submarine boat is the latest step in a long history of evolution from club, bow and arrow, musket, fire-artillery, high explosives, and rapid-fire guns, and in the vista ahead the aerial destroyer may be dimly discerned, and beyond—perhaps, peace. It may be a radical way of healing the disorders of the human race, but it has its analogy in the science of the healing of diseases of the individual, and if one of the functions of the engineer is to act as the surgeon of humanity, let him be provided with the keenest and most effective instruments, that he may do his work promptly and well.

* * *

We take great pleasure in giving space to the subjoined communication from The Parsons Marine Steam Turbine Co., Limited, referring to a quotation used by Mr. A. E. Outerbridge in THE ENGINEERING MAGAZINE for March :

The Editor of The Engineering Magazine.

Sir : Our attention has been drawn to an extract from the *Marine Review*, Cleveland, O., of the 21st December last, which was reproduced in your issue for March, relating to the report of "Lieut. Harold P. Norton, of the Navy, who is Inspector of Machinery for the United States Cruiser 'Albany' at the Armstrong Shipyards, Newcastle-on-Tyne, England."

We scarcely think that Lieut. Norton can have forwarded to his Government such a report as that which is alleged by the *Marine Review*, as it conveys in somewhat strong terms an impression that he had not received due courtesy on the occasion of his visit to these Works, and we desire emphatically to state that Lieut. Norton has received every possible courtesy both from Mr. Parsons and the Officials of this Company, with the usual limitation, naturally imposed, of not showing Lieut. Norton everything in relation to work in progress and the turbine-propelled destroyers in course of construction, one of which—the "Viper"—is for the British Admiralty.

Our sole object in writing this letter is to remove the strong impression conveyed by the article which you quote that anything but the utmost courtesy has been shown to Lieut. Norton.

We are, sir, yours, etc.,
Pro THE PARSONS MARINE STEAM TURBINE CO., LIMITED,
(Signed) C. A. PARSONS,
Managing Director.

We trust that Mr. Parsons is mistaken in thinking that any intimation of discourtesy was intended by the original writer of the paragraph in the *Marine Review*. We are at least very certain that no intention of conveying any such intimation existed in the mind of Mr. Outerbridge or in the office of this Magazine. The point sought to be made was merely that Lieut. Norton was not permitted to make any close or detailed inspection of the motive power of the "Turbinia" and the "Viper," and this seems to be undisputed.

* * *

Those who have had occasion to undertake the translation of technical books, or even to examine technical journals, in English, French, or German, have felt the great necessity for a really good technical dictionary.

It is not that there are no technical dictionaries in modern languages now on the market, but they are so entirely unsatisfactory that few care to use them, nearly everyone finding that the imperfect assistance obtained from a general dictionary is preferable to the incongruities and absurdities with which the so-called technical dictionaries abound.

It is not surprising that this should be the case, for the terms used in the workshop, the laboratory, the mine, and the field are generally arbitrary, and, in many instances, literally untranslatable, so that what is needed is not a translation, but an equivalent expression for the term so expressive to the original user and so meaningless when laboriously and literally translated by the foreign reader.

Admitting the necessity for a really satisfactory technical dictionary, the question arises: By whom can such a work be produced?

It must be the work of many hands, not only of those expert in the languages involved, but in the intimate practical work of the various departments of applied science which constitute engineering, and this, too, in the various languages included. Since the expense involved in producing such a work, if done in the ordinary manner, would probably exceed the returns to be expected from the sale of the book, some other method must be adopted if a thoroughly satisfactory result is to be secured. Such a method might be found as follows:

Let the various national engineering societies, the Institutions of Civil and Mechanical Engineers in England, the American Societies of Civil and Mechanical Engineers, the Institutions of Mining and Electrical Engineers on both sides of the Atlantic, for the English language, unite with the Société des Ingénieurs Civils de France, and with the Verein deutscher Ingenieure and the Oesterr. Ingenieur und Architekten Verein, and such other organisations as might be available, to apportion the work among their various members, each member agreeing to provide the correct technical definition of terms submitted in his special line of work. The preliminary work of translation could be done by ordinary translators, hired by the publishers, illustrations of all articles being provided, so that a knowledge of the several languages need not be possessed by the experts, and the result of this work should, when revised by a competent editorial committee, be the production of an international technical dictionary really worthy of the name.

REVIEW OF THE BRITISH PRESS

The Plateway System.

THE interesting address of Mr. Alfred Holt before the Students' Engineering Society of University College, Liverpool, upon the plateway system of transport for merchandise, is published in full in the *Automotor Journal,* and some of the points which are forcibly put in the address are here abstracted.

The root of the whole matter of transport lies in the fact that a disproportionately large portion of the cost is in the handling, and that even for long distances it costs more to unload the merchandise, reload it on a wagon and haul it to the warehouse, than it did to convey it many miles on a railway. The remedy for this is so obvious that it is surprising that it has not been adopted long ago; it consists simply in so constructing the vehicle and the roadway that the former can be hauled upon an ordinary street or road as well as upon the track, and can thus be taken from the train at any point and hauled by horse or other traction directly to the spot where the goods are wanted.

Mr. Holt's paper considers almost altogether the conditions attending transport in Lancashire, especially in connection with the hauling of merchandise between Liverpool and the great manufacturing cities in the vicinity. The heavy lurry has long been used for horse haulage in these localities, and it is proposed to use a similar vehicle, with two modifications, for the plateway. In the first place, the wheels would be made without flanges, thus permitting the vehicle to be hauled on streets and common roads as usual, and, secondly, couplers and buffers would be provided, and the shafts made removable, so that a number of such lurries, having been hauled by horses to a point on the plateway, might be made into trains and pulled by a steam or electric locomotive to the distant destination, there to be uncoupled and hauled singly to their respective places. The change in the wheels would require the flange to be made upon the track, and it is proposed to lay the plateway along the public highway, all other vehicles having the privilege of its use, since the track could be vacated or resumed at will. A speed of 10 to 12 miles an hour is considered permissible, and it is evident that a large volume of merchandise could be steadily and economically transported in this manner.

The criticism may be made that the speeds above mentioned are too slow to meet modern conditions, but, as Mr. Holt well remarks: "Slow speeds do not necessarily mean slow delivery." Merchandise may be hauled very rapidly for a long distance only to be delayed on a siding at the terminal while the slower means of transport is catching up to it.

The question of vehicles may take altogether a different form from that existing with the railways, the carriers providing their own rolling stock, and the plateway company providing the way and the hauling-engines, taking a toll for the service rendered.

"The practical mode of carrying goods by the plateway would be as follows:

"The lurry being loaded at the ship's side or warehouse in Liverpool, would be horse-drawn exactly as at present to the nearest plateway lines, placed on them if convenient, or at any rate near to them, the long horizontal shaft-bolt would be withdrawn, and the horse would be driven off, carrying the shafts with him. The iron coupling frame would then be unhooked from under the fore body of the lurry, and one end of a rope made fast to it, the other end carried either to the hinder part of the engine or of the preceding lurry, or else taken to a live capstan, and by one of these means the lurry would be pulled into position, the short vertical coupling bolt being then dropped in, the transformation would be completed. Mechanical traction by steam, or preferably by electricity, would then convey it as part of a long train, we will say, to Manchester, where horses, which would be standing waiting, having brought other lurries from Liverpool, would be led up, the coupling frame would be again hooked up under the fore-body, the shafts attached, and the lurry again horse-drawn to destination at either mill or warehouse, its load never having been touched.

"A plateway can hardly be said to have a terminal station at all, for it really ramifies out to nothing at docks, warehouses, or private yards, or even in farmers' fields, but what would represent a terminal station would be entirely different from that of a railway. No goods having to be handled there, all cranes, wharves, warehouses, etc., would disappear; a long narrow unroofed space being all that would be wanted; an arrival line flanked by a road on one side, and a departure line similarly flanked on the other, and between them a central line to enable the locomotive to get from one end of the train to the other. No lurry would be allowed to enter till it was ready for the road, nor would any be allowed to remain on the arrival line. All the labour required would be that of a few men to couple up the lurries into trains, ready for the locomotive, or to break up the trains and attach the horses. Standing room for lurries is not required—the streets and private yards perform that part of a railway station's duty; but standing room for waiting horses might be necessary."

Electric Touch.

THE researches of Professor Jagadis Chunder Bose, of the Presidency College of Calcutta, in the domain of electrophysics, especially in connection with the influence of electric waves upon various materials, have resulted in some valuable contributions both to the theoretical and practical branches of electrical work.

Nearly a year ago Professor Bose made a communication to the Royal Society upon the behaviour of various materials in the coherer, this being the result of a systematic study of the properties to which coherer action in space telegraphy may be due, and in that paper the theory of the chemical nature of the action was advanced. The paper was reviewed in these columns at the time, and now we have, in a further communication to the Royal Society, an account of later experiments and deductions.

The term "coherer" appears to be unfortunate to a certain extent, since it conveys the idea that the particles in the glass tube have their resistance diminished under the influence of an electric wave by somehow sticking together and forming a continuous conductor. While this may be true in some instances, Professor Bose shows that in numerous cases the effect of the electric wave is to cause an increase in resistance, that is, a "de-coherence."

"In the former paper it was shown that though many substances exhibit a diminution of contact resistance, there are others which show an increase of resistance—an increase which in certain cases lasts only during the impact of electric waves, the sensitive substance automatically recovering its original conductivity on the cessation of radiation. There are thus produced two opposite effects, either an increase or diminution of resistance, depending on the nature of the substance. The effect of the increase of contact resistance is not an exceptional or isolated phenomenon, but is as normal and definite under varied conditions as the diminution of resistance noticed in the case of iron filings."

The earlier investigations showed that the sensitiveness of the substance resided upon the surface layer, the nature of the substratum having little or no effect upon the result. A substance which exhibits a strong diminution of resistance, if coated with an extremely thin layer of a substance of the other class, then exhibits an increase of resistance. For this reason Professor Bose has given these effects the significant name of electric "touch," and in his discussion of his experiments he brings out some interesting and possibly important points.

The whole subject is considered as one of molecular physics, occupying the borderland between physics and chemistry, and affords not only an important verification of the identity of visible and electric radiation, but also tends to establish the continuity of all radiation phenomena. The theory of coherence, of Professor Lodge, was supposed to explain the action to a certain extent, but fails to account for the increase of resistance in the case of certain substances, such for example, as potassium. Professor Bose offers the theory that there is a molecular action produced by the influence of the electric waves, of the nature of an allotropic modification due to the difference in the atomic or molecular aggregation. This effect is modified by the chemical nature of the substance. Not only does the nature of the material affect the positive or negative nature of the resistance, but in some instances there is a reversal of resistance, depending upon the intensity of the radiation. Thus with a receiver containing freshly-powdered arsenic there was found to be an increase in resistance when a radiator of great intensity was placed close to the tube. As the radiator was removed the influence became weaker until a critical distance was reached, when the influence was zero, beyond which the action was reversed, and a diminution of resistance was produced.

The effects of tapping to overcome the condition of "fatigue" into which the substance in the coherer gradually falls, are also discussed, and the experiments for a number of substances are plotted in the form of radio-molecular oscillation curves which show very clearly the nature of their behaviour.

Summing up the results of the experiments, it is shown:

(1) That ether waves produce molecular changes in matter; (2) that the molecular or allotropic changes are attended with changes of electric conductivity, and this explains the action of the so-called coherers; (3) that there are two classes of substances, positive and negative, which exhibit opposite variations of conductivity under the action of radiation; (4) that the production of an allotropic modification depends on the intensity and duration of incident electric radiation; (5) that the continuous action of radiation produces oscillatory changes in the molecular structure; (6) that these periodic changes are evidenced by the corresponding electric reversals; (7) that the "fatigue" is due to the presence of the radiation product; (8) that by means of mechanical disturbance or heat the radiation product can be transformed into the normal form, and by so doing the sensitiveness may be restored.

Although these investigations have been conducted in the spirit of pure science, and presented in the form of an academic paper, the important bearing which they have upon the development of space telegraphy is evident, and improved instruments and methods of telegraphing without wires may be expected to result directly from practical applications of the principles above laid down.

The Wastefulness of Chimney Draught.

In a recent editorial discussion of the question of the various methods for the utilisation of waste heat, the *Engineer* considers among other features the wastefulness of the usual method of producing draught by the ascent of heated air in a chimney.

Taking the boiler as the wasteful member in a steam plant, its efficiency varies from 60 per cent. in a bad boiler to 80 per cent. in a very good one, these proportions of the heat produced by the combustion of the coal being realised in steam available for the engine in each case.

"The difference may be said, without greatly stretching the truth, to go up the chimney. It is not to be disputed that much of the waste heat might be caught and utilised; but there are reasons why it is not so caught. In the first place, the gases must be hot when they go into the chimney, or there will not be a draught.

"As a matter of fact a draught got in this way is the most expensive possible, save one. The exception is a steam jet in the chimney. A fan can be run for about one-tenth of the power represented by the waste heat required to command a good draught. A tall chimney will cost from £1,000 to £5,000—very much more than will a fan plant. But the fan is not used and the chimney is, largely because it is essential to discharge the products of combustion high up in the air over the roofs of surrounding houses. This necessity must be taken into account in so far as factories are concerned, but it does not hold good of steamships; yet we believe that in most cases a chimney stack 100 feet high would be sufficient, because with a fan combustion could be more easily controlled than is possible with a chimney, to the end of preventing the giving off of smoke."

This practice can only be expected in newly constructed works, since it is hardly to be expected that steam users with great chimneys and large batteries of boilers will be found willing to make such a considerable change.

Various methods have been devised for utilising the waste heat before it passes out of the chimney, the best-known of these being the Green economiser, but this device is large and expensive, often exceeding the boiler in heating surface, and is altogether unsuited for use on shipboard. Heating coils, however, might be placed at the base of the chimney and in the smoke chambers in such a manner as to return much of the waste heat to the boilers with the feed water.

Other economies might be effected by the use of mechanical stokers, heating of air, air regulation, and close compliance with the theoretical conditions of combustion, but among them all probably the greatest economy would be obtained by the reduction of the loss due to chimney draught.

Boilers for Naval Vessels.

THE discussion upon the well-worn subject of water-tube boilers for naval vessels continues, but on modified lines, and a recent editorial in the *Engineer* shows very clearly the changed sentiment in this respect. Formerly it was water-tube versus cylindrical boilers, but now it is only a question of how to secure a satisfactory water-tube boiler, the Scotch boiler being altogether out of the race. "The Scotch boiler is a thing of the past. It is no more likely to be used again than is the old-fashioned low-pressure box boiler in our ships about the time of the Crimean war."

But the water-tube boiler itself is not an unmixed blessing. There are certain primary conditions to be fulfilled on a naval vessel, and the best boiler is that which most nearly meets them.

"It is all important that the nature of these ruling conditions should be fully comprehended. The primary condition is, that, with a given weight per ship of coal, boilers, and water, the highest possible horse-power may be got. The coal we may regard as a constant. This is not strictly true; but the assumption that it is will not affect what follows, save in so far as it tends to simplify matters. We have then a certain weight for the boilers, and the water in them. The weight of a boiler is made up by the shell, the heating surface, the stays, the fire-bars, and the fittings. If, now, we can so use all our materials, and so design our boiler that nearly all the metal shall be heating surface, it is obvious that, other things being equal, we shall have a much lighter boiler than one in which we have a large quantity of steel disposed in the shape of very heavy shell plates which are not heating surface at all. It is also obvious that so far the condition can only be satisfied by a water-tube boiler. Again, such a boiler will contain the minimum quantity of water. Furthermore, the steaming power of a boiler depends upon the quantity of coal that can be consumed on its grates; and it is a matter of common knowledge that the more slowly the coal is burned, and the less localised the heat, the longer will the boiler last, and the greater will be its economy. Here, again, the water-tube boiler has all the advantage on its side, because the grate may be made almost as large in area as we please; but in the Scotch boiler the dimensions of the grate are bound by limitations which cannot be passed. It is clear, therefore, that from whatever side we regard the question, the water-tube boiler complies with the conditions that for a given weight of steel and water will supply more steam per hour than the Scotch boiler."

The Belleville boiler was adopted for the British navy because it had already been extensively used by other nations. Precedent ruled, although it was evident to many engineers that the Belleville design was not all that could be desired. The steam generated in the lower tubes must work its way up through the water in the tubes immediately above, thus necessarily producing foaming, and involving some form of subsequent drying before the steam is fit for use.

Pitting and wasting of the tubes have caused much trouble in practical operation, and it is quite possible that this is in part due to frothing and defective circulation. Whatever the various causes of dissatisfaction, there is little doubt that, while the water-tube boiler is undoubtedly the boiler of the present and future, it should be a better water-tube boiler than any of those now in use.

So far as the practice of other countries is concerned, it is evident that the Belleville is not the only boiler which is thought suitable for naval use. The Babcock & Wilcox boiler has given good service in vessels of the United States navy, and the Niclausse boiler has been extensively introduced in naval vessels of France, Italy, the United States, and other countries, for powers ranging from 10,000 to 20,000 horse power; while in the Dutch navy the Yarrow boiler has been adopted.

Surely with the experience thus developed, the design of a reliable water-tube boiler should be sufficiently removed from the realm of experiment to enable the conditions to be examined systematically and a steam generator designed in the same manner as an engine or a machine tool.

Condensation in Steam-Engine Cylinders.

One of the largest losses in the conversion of heat into power by means of steam is known to be that due to condensation in the cylinder, and many theoretical and practical discussions have been given to the problem of reducing this loss.

The subject naturally presents many difficulties, not the least of these being the impracticability of seeing the interior of a steam cylinder under normal working conditions, and the necessity of assuming to a great degree exactly what goes on within it. It has usually been assumed that the chilling action of the cylinder walls condenses a portion of the incoming steam, forming a film of water which is subsequently re-evaporated during the expansion after cut-off.

In order to remove as much as possible the uncertainty concerning the nature of the action of steam in a cylinder, Mr. Bryan Donkin devised, a number of years ago, an instrument which was named by Hirn a "Revealer," and which was intended to permit the production, in a glass cylinder connected to the steam cylinder of an engine, of a visible evidence of the phenomena of cylinder condensation. This instrument has been subsequently much improved, and in a paper recently presented before the Institution of Mechanical Engineers, Mr. Donkin gives a description of it, together with an account of some observations made by its assistance.

The revealer is designed to reproduce as nearly as possible, and render visible, what takes place inside the steam cylinder. It consists of two cylindrical glasses, one inside the other, fixed concentrically, the space between them forming a hot-air jacket, and the inner cylinder connecting with the steam cylinder of the engine under observation, by means of a short, straight pipe, a stop-cock of direct, wide opening being provided. Inside the inner glass is a small cast-iron cylinder, and all the external metal and glass surfaces, with the exception of the openings for observation, are well covered with non-conducting material to diminish radiation.

Although the conditions cannot be made exactly the same as in the interior of the cylinder itself, Mr. Donkin maintains that the effects of condensation, as shown by the revealer, may be within 85 to 95 per cent. of the truth, and all results can be accurately seen, magnified, and studied. By the use of a ruled scale on the surface of the interior cast iron cylinder, giving areas of one square milimetre, it is possible to estimate, under suitable magnifying power, the sizes of globules of steam, with a useful comparative degree of accuracy.

Mr. Donkin describes in detail a number of observations made on a compound beam engine, working condensing, at a speed of about 35 revolutions per minute, both with the revealer as above described, and with a modified form in which a thermometer was inserted into a cavity in the interior cast-iron cylinder, enabling the temperature to be compared with that of the steam as computed from the pressures shown on the indicator diagrams.

The general behaviour of the steam was revealed as follows, on the low-pressure cylinder.

"Commencing with the steam stroke, the first result observed, when the steam is admitted to the revealer, is a light and not very dense cloud or white fog coming up from the engine cylinder. This is precipitated on to the hot internal glass and cast-iron walls, and is seen as very fine globules or particles of moisture or condensation. This cloud is sufficient to obscure a light placed on the opposite side of the revealer. Re-evaporation then very rapidly follows before the end of the steam stroke. On the opening of the exhaust valve, the cloud passes quickly off into the cylinder, and the glasses become quite transparent.

"Each time the steam enters, a large number of very small globules, at about equal distances from each other, are immediately seen upon the glass walls. These are from 1-20th to 1-25th of a millimetre in diameter, or less, and are distributed in a fairly uniform manner over the entire surfaces. The time occupied by the deposition of the globules, and their re-evaporation, is perhaps a tenth of a second. Before the end of the steam stroke, the duration of which is about half a second, and before the exhaust valve opens, the smaller globules, 1-25th of a millimetre in diameter, are all evaporated. During the exhaust stroke, the larger globules are also re-evaporated, but not so quickly. The internal surfaces are sometimes quite dry, and at other times a few drops of moisture remain on them."

A similar action takes place in the high-pressure cylinder, the only marked difference being in the size of the globules, these being much larger in the high-pressure than in the low-pressure cylinder. The influence of the jackets was clearly seen in the revealer, and experiments made with artificial cooling showed the instruments to respond promptly to any changes in conditions.

Although the experiments have as yet not been extended to quick-running engines, the information already obtained confirms to a great extent what had already been supposed to take place in the inside of a steam-engine cylinder. One result, however, seemed to prove that there does not exist any thin film of condensation water on the internal surfaces of steam-engine cylinders, whether the cylinder is hot or cold, the moisture always appearing in the form of drops or globules. The only effect of differences of temperature between the walls and the working steam seems to be the difference in size between the respective globules of water.

Mr. Donkin proposes to continue these interesting experiments, and they will doubtless also be supplemented by those of other observers, thus materially extending our knowledge of the important subject of cylinder condensation.

Power Required by Machine Tools.

There have been many attempts to determine the amount of power to drive machine tools when performing various kinds of work, most of these investigations having been made with the aid of special forms of dynamometers interposed between the machine and the motive power. In some instances the power has been measured by comparing consecutive indicator diagrams taken from the engine, the condition of the work on the machine being noted at the time of the taking of the diagram. With the introduction of independent electric driving, however, the measurement of the power absorbed has become materially simplified, and by the use of automatic recording ammeters the electric energy supplied during any operation may be determined very conveniently.

A number of experiments have been made at the Atlas Works, Sheffield, under the supervision of Captain Tressider, upon the power consumed by electric motors in driving heavy tools, and a summary of the results, together with diagrams from the recording instruments, is given in a recent issue of the *Engineer*. The ammeter gives only the amperes, and from this the power in watts is deduced on the assumption that the voltage remains constant. This latter assumption is not strictly correct, but the fluctuations are not large enough to affect the general value of the results, and in the tests it appears that a fairly constant presure of 220 volts was maintained.

The general system of driving involved the use of raw-hide pinions on armature shafts, driving steel spur wheels on driving shaft, from which direct belting connected to the machine pulleys. The motors were principally of the standard sizes of twenty and twelve horse power, with a few smaller sizes for special purposes, and their efficiency was estimated at 85 per cent., or four amperes at 220 volts required for each brake horse power.

These motors were employed in driving heavy planing, drilling, and slotting machines, working upon very tough steel, of a breaking strength of 45 to 60 tons per square inch. This material does not permit of the maximum power being put into the machines, since the limit is not the strength of the machine, but the edge-holding power of the tool steel.

The diagrams from the recording instruments show the irregular demands of the various tools very clearly. Planing machines, especially, are least well adapted to separate electric driving, on account of the large and constantly recurring variations of power demanded. For this reason it is considered better to arrange such machines for group-driving, and until motors can be made to run in parallel at all loads, at least three planing machines should be driven by one motor.

"The separate driving adopted in the present installation gives no trouble; but it will be seen from the diagrams that the conditions of a separately driven planing machine are most unfavourable to high motor efficiency. Several methods have been adopted for cutting down the "peaks" of the diagrams. In addition heavy fly-wheels, with a periphery speed of nearly 5,000 feet per minute, have been adopted on the armature shafts to modify the speed variations; and for the same reason all pulleys on the driving shafts for planing machines have been made of cast iron, and especially heavy in the rim."

An examination of the data given for the various tools will be of interest. Thus with a heavy double-screw planing machine the power required for starting appeared to be nearly the same whether the machine is empty or loaded, ranging from 22½ to 24 horse power, while during the stroke it required 7½ h.p. empty, and 12 h.p. when cutting an 8 ton plate. A rack driven planer of similar character showed a consumption of considerably less power than the screw driven machine, but the jerky character of the motion renders it less desirable as a tool. A large radial drill consumed 2 h.p. running empty and 3 h.p. drilling a 3⅜ inch hole, while the tapping of such a hole consumed from 3 to 6½ h.p., the variation in the latter case being due to the unequal amount of work done by the successive taps. A large slotting machine, taking a cut 1¼ inch wide with 1-80 inch feed, required 15 h.p. during the cutting stroke, and 10½ h.p. for the return, against the unbalanced weight of the tool arm.

These figures are, of course, of only general application, although it will be interesting to compare them with similar service as measured by the dynamometer. The method of measuring power, however, appears to be susceptible of wide application, particularly in mechanical laboratories and research departments of engineering schools, and training in electrical measurement might thus be combined with the accumulation of a large amount of data of great value to the designers and users of machine tools.

Portable Pneumatic Tools.

THE idea of bringing the tool to the work rather than that of bringing the work to the tool is by no means new, but its practical execution has been limited by the progress of methods for the convenient transmission of power. Many years ago portable drills, driven by rope gearing with a weight take-up in a slack loop of the rope, were introduced. These were followed by the use of the flexible shaft, still employed for short connections, but at the present time the principal methods employed for driving portable tools are electricity or compressed air.

Portable pneumatic tools have been more extensively used in the United States than elsewhere, and a recent paper by Mr. Ewart C. Amos before the Institution of Mechanical Engineers is devoted mainly to a discussion of some of the convenient and effective devices which have been produced for enabling chipping, riveting, caulking, drilling, and various other operations to be performed upon any large piece of work, either in position, or upon the shop floor.

The most important of these tools are those of the hammer type, in which a plunger is given a very rapid reciprocating motion in a cylinder, the latter being provided with such handles as will enable the workman to hold it up to the work. With the exception of the rotating motion, such a tool resembles a miniature rock drill, and the interior construction is not greatly different. The air is delivered through flexible tubing, so that the tool can readily be taken to any point about the work, and by the use of chipping or caulking chisels the work can be done at a rate entirely out of the question by any hand method.

The so-called "valveless" hammers are are those in which there is no independent air valve, its place being supplied by passages in the plunger itself. These hammers have a short but very rapid stroke, sometimes reaching 10,000 to 20,000 strokes per minute, and are suited for such work as beading flues, light caulking and chipping, and carving in stone. The valved hammers have a longer and less rapid stroke, and deliver a more powerful blow, and are adapted for general and heavy chipping, caulking, and riveting. The usual speed for such tools is from 1,500 to 2,000 blows per minute, although they can be driven much faster.

It is an interesting and well-known fact that the nature of a blow, whether light or hard, produces an effect on various materials apart from the actual work done as measured in foot pounds. Thus, 10,000 small blows, representing a certain number of foot pounds, might fail to produce a desired result, which a smaller number of heavy blows, representing less energy in foot pounds, might effect.

Mr. Amos gives detailed illustrations and descriptions of a number of well-known hammers, with sizes and air consumption, but calls attention to the fact that the air consumption will differ greatly in the hands of different workmen, and that the air consumption is not alone indicative of the efficiency of a tool. It is also necessary that a hammer should be selected of suitable weight for the work which is to be performed. No tool can be adapted to all classes of work. It is not uncommon to find operators attaching blame to a tool on account of its failing to do its work when the real cause of failure is due to the application of the wrong tool.

Riveting has been successfully performed by compressed air tools for some time, the earlier machines having been of the type operating by squeezing. This work can also be performed by the pneumatic hammer by having it fitted with suitable snaps, and in the hands of skilful operators these machines are very useful, owing to the limited space in which they can be used. Yoke riveters are also extensively used, one arm of the yoke being fitted with what is practically a percussion hammer, while the other is a solid holder-up. Both types are fully illustrated in the paper of Mr. Amos. He also shows various forms of pneumatic drills, hoists, and other tools, and gives an interesting table showing the saving in time and labour by the use of the tools as demonstrated at important railway shops and machine works in various parts of England.

"When making comparison of the cost of work as between pneumatic tools and hand labour (and it must be borne in mind that they compete largely with hand labour) it is necessary to take into consideration three points: (1) That with the same sized shop and the same standing expenses in the form of rent, rates and taxes, and wages bill, a very great deal more work can be turned out in the same time. (2) That although against this there must be set off the cost of producing the compressed air, yet even supposing this equalled the cost of manual labour (which it does not) there would still be a considerable saving for the reason given in item (1). (3) That with hand-labour, especially in riveting, caulking, and place drilling, work can only proceed at a comparatively slow rate, however many men be employed, and however closely together they work. This frequently becomes a serious matter in ship and bridge building, railway works, etc., and even were the cost double that of hand labour, other advantages as regards speed, etc., would outweigh it; but as a matter of fact, when properly carried out, the saving is very considerable, and it is in the author's opinion only a question of time, and that not very far distant, when every engineering shop will find it absolutely necessary, if it wishes to keep in the van of progress, to adopt the pneumatic or some similar system of portable tools."

REVIEW OF THE CONTINENTAL PRESS

Hammer-Blow in Water Pipes.

THE action of the so-called "hammer-blow" in water mains has made itself apparent so often that the effects, at least, are well known. Precise knowledge of the causes and actual magnitude of these shocks, however, has been lacking, the experimental study of the subject having been very slight, until recently. Some experiments made by Professor R. C. Carpenter, of Cornell University, at Ithaca, gave data concerning water-hammer in small pipes, but apart from these, the subject had not been scientifically investigated until some recent, and very valuable experiments made in Russia.

These experiments, made under the supervision and at the instance of M. Nicholas Simin, Chief Engineer of the Moscow Waterworks, and conducted in detail by Professor N. Joukowsky, of the Moscow Imperial Technical School and the Moscow Imperial University, are discussed very fully in a paper presented by Professor Joukowsky before the Imperial Academy of Sciences of St. Petersburg, and from this paper the following abstract is made.

The observations were made upon pipes of 2, 4, and 6 inches in diameter, these being laid upon the ground and connected with the 24 inch main of the Moscow water system; valves at the ends of the pipes enabling the flow to be interrupted very quickly to produce changes in the hydrodynamic pressure in the pipes. The results of the tests are especially interesting, since they show what had hitherto not been known, that all the phenomena of hydraulic shock may be explained by the formation and propagation of shock-waves in the pipes, these waves being due to the compression of the water and the extension of the walls of the pipe.

After a review of the various theoretical studies which had previously been made of the action of shock in water-pipes, including the account of the experiments of Professor Carpenter, Professor Joukowsky goes on to describe the arrangement of the apparatus used in making the tests from which his deductions were made. The pipes were laid in the yard adjoining the Alexiew pumping station, the lengths being as follows: 2 inch, 2,494 feet; 4 inch, 1,050 feet, and 6 inch, 1,066 feet. The pipes were so laid that the terminals came close to the points of departure from the large main, thus enabling the same observers to control the closing of the valves and the observation of the instruments at both ends. Arrangements were provided for weighing the quantity of water discharged from any pipe in a given time, and by previous calibration the velocity required to discharge a known weight of water had been determined, so that this weighing of the water gave an accurate measure of the velocity in a pipe at any experiment. Several devices were employed for determining the pressures. A series of Bourdon pressure gauges were placed at known intervals along the lengths of the pipes, these gauges being provided with friction indicators, showing the maximum pressure to which the needle attained for any test. The rapidity of propagation of the shock-waves was measured by a Marey chronograph, recording, by means of electrical connections, the time of shock at points 700 feet distant, while the rise and fall of pressure at various points in the pipes was recorded by a special arrangement of the Crosby indicator. The corrections required in the use of these instruments are discussed in the paper, and the readings are tabulated and specimens of the diagrams given.

It is impossible with the limited space here available to go into the details of Professor Joukowsky's investigation, and for this the reader must be referred to the original paper, but the conclusions are of sufficient importance to be given in full.

1. The hydraulic shock is propagated along the pipe with a constant velocity, which, so far as could be observed, is independent of the magnitude of the shock. This velocity is dependent upon the ma-

terial of the pipe and upon the ratio of the thickness of its walls to the diameter of its bore. For ordinary cast-iron water pipe this ratio diminishes somewhat as the diameter increases, and hence the velocity of the shock-waves is somewhat less for large pipes than for smaller ones. For pipes of moderate size, 2 to 6 inches bore, the velocity is about 4,200 feet per second, and for larger pipes, say 24 inches bore, it is about 3,290 feet. The velocity of the shock-wave is the same whether the shock is produced by suddenly arresting the flow at the discharge of the pipe, or by suddenly raising the pressure at the beginning.

2. The hydraulic shock acts with uniform force upon the length of the pipe. Its magnitude is proportional to the loss in velocity of the flow of the water and to the velocity of propagation of the shock-waves in the pipe itself. For ordinary cast-iron pipe of 2 to 6 inch bore we have for each foot of velocity lost by the water a shock of about 4 atmospheres, while for a pipe of 24 inches diameter the shock is about 3 atmospheres.

3. The existence of a periodical oscillation of a shock in a water pipe is indicated by the reflection of the shock-wave between the beginning and end of the pipe.

4. The flowing water has apparently no influence upon the shock, this appearing to be dependent only upon the loss of velocity. The shock is reflected just the same in a pipe through which water is flowing as in a vessel containing stationary water, other conditions being equal.

5. A dangerous increase in shock may appear in the passage of the shock-wave from a pipe of large diameter to one of smaller diameter. In such a case the force of the shock, when it reaches the closed end of the pipe, is doubled, and as this doubling may be repeated several times, the pressure may attain great magnitude.

6. The simplest method of preventing shocks in water pipes is to introduce devices compelling the slow opening and closing of valves and cocks. For this purpose the time required to close the valve should be proportional to the length of the pipe. Air chambers, if placed in the line of the pipe near the valve, will prevent the shock almost entirely, but it is difficult to keep them filled with air. If a safety valve is placed upon the pipe to relieve the pressure it leaves a shock depending upon the strength of the spring.

7. Shock diagrams taken from different points in a pipe enable the position and magnitude of accumulations of air to be determined. The shock diagram may also be used to determine the location of a leak in a pipe, and to obtain general information as to its condition.

Hand Labour and Machine Work.

In these days of automatic machine tools, and the development of plans on every hand to dispense with the greater part of the skilled labour formerly required in industrial operations, the very elaborate study of the growth of labour-saving machinery, and comparison of the relative value of the two methods of work, by M. E. Levasseur, in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* forms an important contribution to industrial literature.

After referring briefly to the early antagonism of hand workmen to labour-saving machinery, and the attempts to destroy such machines as the Jacquard loom, the spinning jenny, and other inventions, M. Levasseur goes on to examine the apparent paradox involved in the idea that labour-saving machinery will enable a better product to be made at a reduced cost and at the same time furnish a greater return of profit to both labourer and capitalist. This he shows is more apparent than real, and arises out of the confusion of the value of the single piece with that of the total output. Machinery enables so much more to be produced in a given time that the pay per piece may be greatly reduced, while the earnings per day are materially augmented.

After various quotations from the report of Hon. Carroll D. Wright, the United States Commissioner of Labour, showing the effect which the introduction of machinery had produced upon the development of wealth in America, comparison is made with similar reports regarding industry in France. Among these the most complete is that of M. Bechmann, the Chief Engineer of the water supply and sewerage of Paris, giving data as to the execution of sewer construction by hand and by use of the shield; also data concerning the influence of machinery upon other trades, such as glass-polishing, mining, and other branches of work in which improved mechanical appliances have worked a revolution.

In all of these examples it is shown that the introduction of labour-saving machinery has not only made possible a greatly increased productiveness of an improved article at a great economy, but also that these most desirable results have been accompanied with the provision of occupation of an increased number of workers at higher wage rates. The capacity for supplying products at prices which render an extended consumption possible, provides in nearly all cases for constantly increasing markets which it creates, and in all parts of the world prosperity is found accompanying modern facilities, while poverty and degradation are associated with the primitive methods in which the productive capacity of the worker is limited by the crude tools and methods.

M. Levasseur's paper is accompanied with numerous illustrations of labour-saving devices of many kinds, especially those of recent American design, and the whole subject of the economic effects of such devices is discussed in a judicious and intelligent manner.

The Charlottenburg Testing Laboratory.

THE general report of the work of the Royal Testing Laboratory at Charlottenburg, near Berlin, contained in the last issue of the *Mittheilungen,* gives an excellent idea of the varied scope of such an institution, and emphasises the great value which it renders to all branches of technical industry.

As is well known, this important institution is under the able direction of Professor Martens, who is aided by four principal assistants, and a number of subordinates, the total force numbering 74 persons, of whom the greater part are experts and specialists, there being included also the special clerical force for the proper care of records and accounts. The laboratory is equipped with the latest and most improved machinery and apparatus, much of this having been designed by Professor Martens and his associates, and the official character of the institution lends an assurance of reliability to tests there made which cannot be felt with any private laboratory, however high its standing.

The work during the past year showed an increase of about 50 per cent. over that of the preceding year, and it is interesting to note that out of a total of 295 investigations, but 37 were for official purposes, the remaining 258 being for private applicants, the whole involving 4,112 tests of various kinds.

Nearly one-half of these tests were of the tensile strength of various materials, including steel, iron, copper, and various alloys, also of rope, chain, belting, and similar materials; while about one-fifth were compression and buckling tests, not only of metallic substances, but also of concrete, timber, and other building material.

Among the other tests may be mentioned flexure, torsion, and drop tests of metallic subjects, friction tests of bearing materials and of lubricants, trials of the heat-insulating properties of pipe coverings, of the tightness of packings, and of the efficiency of abrasives. Tests have also been made of the strength of steel balls, and the causes and nature of cracks investigated. Some interesting studies of the resistance of steel wire of different degrees of hardness against the action of rust have been made, as well as the extent to which rust diminishes the strength. The influence of annealing and tempering upon steel castings forms a valuable series of investigations, and the tests of rubber hose under the influence of heat and steam pressure gave definite data upon a subject about which little had previously been known.

It would be impracticable to review in this place the extended list of important investigations of the year, but many of them have been reviewed at length in these columns as the reports were made public in the *Mittheilungen,* or *Transactions* of the laboratory. The extent and thoroughness of these reports form no small part of the value of the establishment to the engineering world at large, for while there are many minor tests which are of but little value to others than those directly interested, many of the investigations have their value largely increased by the scientific manner in which they are discussed. In many cases the bare data and results of a series of tests would be almost useless to the general manufacturer or constructor, while a careful analysis of the figures by a specialist and expert enables conclusions of much practical value to be drawn. The active interest taken by Professor Martens and others of his staff in the work of the international association for testing materials should do much to render the work of the laboratory acceptable to engineers in all countries, since the records there made will doubtless be in conformity to the recommendations of the various sections of the association, and hence strictly comparable with each other and with subsequent tests. It is only by such systematic and organized institutions that definite and permanent progress in a knowledge of the materials of construction can be attained, and the work of the Charlottenburg laboratory will doubtless be a constantly increasing factor in the development of the work of the engineer and constructor.

The Automobile Trolley.

THE greatest obstacles to the use of the electrically propelled motor vehicle for road service has hitherto been the limited capacity of the storage battery, so that recharging is found to be necessary after a run of about 30 miles.

In order to obviate this difficulty the idea has several times been suggested that the current be supplied by an overhead wire, much in the same manner as in the case of the trolley tramway, but in practice a number of difficulties have been encountered with the execution of the idea. Any attempt to provide a trolley pole reaching to the wire above is impracticable, since the vehicle must be able to turn out to avoid passing teams or other carriages, and anything which would deprive the automobile of the flexible control possessed by the independent vehicle would certainly be considered objectionable.

The latest attempt to solve the problem is that of the auto-motor trolley of M. Lombard-Gerin, of which fully illustrated descriptions are given in recent issues of *Le Génie Civil* and *La Revue Technique*. In this device the communication with the overhead wires is made by means of a small motor trolley, riding on the wire itself, and propelled by its own motor, the speed of this motor trolley being automatically regulated by that of the motor on the vehicle.

The arrangement of the device, which is very ingenious, is as follows: Two wires are provided, forming a complete metallic circuit, and through the contact of the two wheels of the trolley the continuous current is delivered by means of a flexible conductor, to the motor on the vehicle. The motor on the vehicle is provided with three rings connected to the winding at the proper points and provided with collectors, so that a three-phase current is delivered through conductors forming a part of the flexible cable, to a small squirrel-cage motor mounted in the trolley. The revolutions of this motor propel the trolley along on the conducting wires upon which it is carried, and, as the speed of its motor is controlled by the speed of the motor on the vehicle, it keeps pace with the main vehicle without requiring any attention whatever. In order that the trolley shall always keep ahead of the vehicle, it is arranged to have a slightly greater speed of travel than the carriage, the difference causing a small amount of slip, keeping the flexible cable well stretched out ahead. An electromagnetic brake, operated from the vehicle, enables the trolley to be stopped positively when necessary.

The device has been given a number of trials on an experimental section of roadway of 900 metres in length along the left bank of the Seine, and, from the photographs which have been reproduced, the vehicle appears to have been well under control, turning out for heavy teams or opposing vehicles as readily as if its motive power were self-contained.

The applications of such a system are numerous, and well worthy of consideration. Apart from affording opportunity for continuous road travel for electrical vehicles, it permits the extension of the radius of suburban trolley lines, automobile feeder lines radiating out from the terminal stations of such lines, and bringing passengers to whom the road would otherwise not be accessible. Current for such purposes could be furnished by the local electric-lighting stations, thus furnishing an increasing daylight load for such installations. In mountainous countries, such a highway trolley system might be installed to great advantage, especially as the current could in nearly all instances be furnished by the utilisation of local water powers, and the laborious hauling of loads by animal power be avoided.

It is proposed to make all the automotor trolleys interchangeable, so that vehicles going in opposite directions may pass each other by exchange of connections, and the details of the apparatus, as illustrated in the articles referred to, appear to have been well worked out in every respect. The system thus stands midway between the electric tramway and the independent automobile, and will probably fill a function now not practicable for either.

The Development of Madagascar.

THE work of the engineer constitutes an important portion of the military strength by which savage countries are conquered by civilised nations, and when such conquests are achieved it is by the work of the engineer that the benefits of civilisation are introduced and perpetuated.

Since the acquisition of Madagascar by France a number of plans have been made for the exploitation and improvement of the country, and the character and progress of these works form the subject of an article by M. A. Dumas in a recent issue of *Le Génie Civil.*

Before the French occupation, the island of Madagascar was almost without improvements of an engineering character, the native roads being little more than rude paths, while the few harbours were practically natural anchorages without artificial improvement. Since the country has been pacified, however, numerous evidences of improvement have appeared, notably in regard to means of communication, and some account of these is appropriate here.

The island of Madagascar, which is 1,030 miles long and 360 miles wide, possesses three distinct varieties of territory. The first, the sea coast, has a very warm climate and a fertile soil, and in spite of the few good harbours access is readily had to nearly all parts by water. The second portion is the intermediate region, lying between the coast and the higher central plateau, and consists of a broken and irregular country, the ascent to the plateau being traversed by numerous rivers, and capable of sustaining but a limited population. The central part of the island forms, in part, an extended plateau, and in part a mountainous country, the elevation varying from 4,000 to 5,000 feet above the level of the sea. This is the most desirable part of the entire country, and is well populated, being occupied by the two principal tribes, the Hovas, whose capital is Tananarive, and the Betsileos, whose principal city is Fianarantsoa.

The main undertaking of the French engineers at the present time is to effect satisfactory communication between the sea coast and the plateau, and especially to construct a railway between the harbour of Tamatave, on the east coast, with the capital of Tananarive. There had existed for a long time a native foot path from the harbour of Andevorante, about 60 miles south of Tamatave, to the city of Tananarive, as well as a path along the coast from Tamatave to Andevorante, but these were only available for foot travelers, and the road to Tananarive contained some very steep and difficult grades. During the war military supplies were sent by a road from Majunga, on the west coast, using the navigable waters of the river Betsiboka for a portion of the way, and being carried by native porters for the balance, and although this road contains some very steep grades it is now being improved and will be converted into a wagon road hereafter.

Several attempts were made to finance a railway from Tamatave to Tananarive by offering land concessions to private companies in return for the assumption of the construction works and operating privileges, but these having fallen through, the work has been undertaken directly by the colony, a loan of 60 million francs having been negotiated, not only for railway construction, but also for highways, telegraphs, and harbour improvements.

Several routes have been surveyed for the railway from Tamatave to Tananarive, the most favourable being that advocated by Colonel Roques, the plan and profile of which are given on a map accompanying the article referred to. It is an interesting fact that this plan includes the proposition to employ rack railways on the steeper grades, using electric traction, the current being generated by the utilisation of the numerous rapid streams flowing from the table land to the sea coast. The cost of the road is estimated at about 47,500,000 francs, and 27,000,000 francs have already been appropriated for the immediate construction of the section between Tananarive and Anivero. The total length of the railway, according to the survey of Colonel Roques, is about 247 miles, the plan being necessarily very circuitous.

Another important enterprise in Madagascar is the opening of a landlocked waterway along the coast, between the harbours of Tamatave and Andevorante. The eastern coast of the island contains many lagoons and bays, practically landlocked, and giving opportunity, by cutting a few barriers, to provide a continuous and unimpeded water-way between the two harbours. The cutting of the "pangalanes," as the barriers between the lagoons are called, was begun at the close of 1897, and more than one-half of the work will be completed before the close of the present year. A short line of railway is already built from Tamatave to Ivandra, where the practicable water-way begins, and the completion of this work will place both harbours in commercial communication with the capital as soon as the main railway is finished.

There appears to be little doubt that the energetic manner in which the various projects for the exploitation of the island are being pushed will result in a rapid development of the native products of Madagascar, and there appears to be every reason to believe that the colony will assume a position of great commercial importance in a few years.

Large Gas Engines.

One of the most convincing evidences of the progress which is being made in the use of gas as a motive power is the increasing attention which is being paid to the design of large gas engines, that is, of engines ranging from 100 to 600 horse-power and over, as compared with the former range of capacity of 5 to 50 horse power.

A general review of the development of the large gas engine, showing the lines along which progress has taken place, is contained in a paper by Professor E. Meyer, published in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, from which the following abstract is taken.

The possibility of extending the scope of the gas engine to large powers was seen after the applicability of lean, or producer gas, as a fuel for internal-combustion was demonstrated, and with the extension of this idea to the utilisation of blast-furnace gases it became evident that the field for the large gas engine was open.

Among the early gas engines of more than 100 horse-power may be noted the engine for the pumping station at Basle, this being of 160 h.p., erected in 1894, an account of its test being given in these columns in the issue for February, 1897. This was followed by still larger engines, especially those intended for use with blast-furnace gases, and now engines ranging as large as 600, 1,000, and even 1,200 h.p. have been constructed.

Since the Beau de Rochas cycle, generally used on internal combustion motors, gives but one power stroke in every four, such engines are necessarily larger than steam engines of the same power, notwithstanding the fact that the mean effective pressure is higher. The high pressures demand increased dimensions in the connecting rods and shaft, this latter detail being also affected by the fact that the irregularity of impulse requires the use of a very heavy fly wheel. The high temperatures introduce further mechanical problems, involving the introduction and circulation of cooling water, while the question of ignition has been a troublesome one from the first. All these details become increasingly difficult to handle in engines of large size, and it is only recently that they have been practically surmounted.

Professor Meyer gives an illustration of the Körting gas engine as a typical design for a single-cylinder motor, suitable for capacities of 120 h.p. and under, but for larger engines it is desirable that more than one cylinder be used, not only to avoid the use of inconveniently large diameters, but also to enable the impulses to be delivered more frequently, permitting the use of relatively lighter fly wheels, and a better distribution of working stresses. Several arrangements of multiple cylinders are possible, and of the more general forms schematic diagrams are given. One form employs two cylinders placed side by side, the two cranks being at an angle of 360°, that is, in line with each other, the fly wheel being between. When one cylinder is making its power stroke the other is drawing in its charge, and when one is compressing the other is exhausting, power strokes thus being made by each cylinder alternately. In another design the two cylinders face each other, being on the same axis, both connecting rods being coupled to the same crank, the crank shaft lying between the two cylinders. This places the cranks virtually at an angle of 180° with each other, the charging stroke of one cylinder coinciding with the compression stroke of the other. For large engines this latter arrangement is sometimes doubled, there being four cylinders, and consequently one power stroke regularly succeeding another, or two to each revolution. The third arrangement has the two cylinders placed tandem, the pistons being upon one common rod, this design requiring but one connecting-rod and crank. The principal objection to this plan is that it involves the use of a stuffing box between the two cylinders, which is not such a simple matter as with the steam engine, owing to the high temperatures existing. Such engines have been successfully made, however, by Körting, the piston rod being made hollow, and cooled by a circulation of water through it. This construction, however, is more expensive than the double-cylinder engine with side by side cylinders.

The largest single-cylinder engines which have been put into practical operation until now are those made by the firm of Cockerill at Seraing, for the purpose of utilising the gases of blast furnaces for driving blowing engines. Four of the engines have been erected at the iron works at Differdingen, each being of 500 h.p., with cylinders of 51.18 inches bore (1,300 mm.), and 55.12 inches stroke (1,400 mm.), making 80 to 90 revolutions per minute. In these engines the piston rod is prolonged through the cylinder head and connected directly to the piston of the blowing cylinder.

A new form of double cylinder gas engine, adapted for large powers, is that of Oechselhäuser, constructed by the Berlin-Anhalt Maschinenbau Aktien Gesellschaft. In this engine the two cylinders are open at both ends and are bolted together end to end, forming practically one cylinder of double length. The two pistons move in opposite directions, the one nearest the shaft being connected to a centre crank, and the other connected by return rods to two return cranks. An air pump is operated by a prolongation of the rear piston rod. There are neither exhaust nor charging strokes, the burned gases being expelled during the last eighth of the stroke by the entrance of compressed air from the blowing engine, a side port near the end of the stroke being provided for the purpose. The compressed charge is delivered into the cylinders during the first eighth of the return stroke, after which compression takes place, so that every out-stroke is a power stroke. Indicator diagrams show an excellent action, and tests show a consumption of 3.5 cubic metres of furnace gas of a calorific power of 900 to 1,000 calories per cubic metre, per horse-power-hour, an efficiency of 18 to 19 per cent. Fuel economy, however, is a matter of minor importance when the combustible is a by-product, as is the case with blast furnace gases.

In using furnace gases in motors it is most desirable to secure the proper mixture of air and gas, and it is found that the proportion of air to gas bears an important relation to the degree of compression. For moderate or low compression it is better to have a larger proportion of air in the mixture, while with higher compressions less air is required.

Professor Meyer discusses many details of gas engine design, especially with regard to large motors using lean gas, and his paper should be consulted by all who desire to realise the conditions under which the gas engine is competing with steam.

The Splugen Tunnel.

The demand for increased railway communication between Switzerland and Italy seems to warrant the development of improved routes, and no sooner is one enterprise for piercing the Alps fairly started than another is agitated. The Mont Cenis was followed by the St. Gotthard and the Arlberg, while the Simplon is now being actively pushed, and this will probably be followed by a tunnel at the Splügen Pass, the preliminary schemes for which are given in a recent issue of the *Schweizerische Bauzeitung*.

The idea of a connection between eastern Switzerland and Italy is not new, having been discussed as long ago as 1886, when preliminary surveys were made under the joint auspices of the Splügenkomitee on behalf of Switzerland, and the Società Adriatica on the part of Italy. The plans included a railway from Chur, in Switzerland, to Chiavenna, in Italy, to which points railway connections already existed, the length of new railway thus required being about 61 miles.

The estimated cost of the road, according to the plans of the Italian engineers, was 146,600,000 francs, and the magnitude of the amount led to a postponement of the scheme until a further inspection of the various possible routes might make it sure that the most economical plan had been chosen. The matter was therefore referred to the well-known Swiss engineer, Herr R. Moser, by whom the article referred to was written, the object being to select a route which should conform to the following conditions:

1. The highest elevation of the road must not be more than 1,200 metres above the sea.

2. The maximum grade on any open part of the road must not exceed 2.6 per cent., and in tunnels of more than 600 metres in length it must not exceed 2.3 per cent.

3. No curves may be of less than 300 metres radius.

4. The grades in the main tunnel must not exceed 0.6 per cent.

5. The road is to be planned for single track, except for the portions between the stations nearest the tunnel and the tunnel portals, and in the tunnel itself, where the road is to be double track.

6. The line of the road in the Bergell valley is to lie as near to the Swiss frontier as possible.

Herr Moser proceeds to examine the Italian route, giving plans and profiles, and shows that by a modification the cost may be materially reduced. Both plans involve the construction of a main tunnel, 18,640 metres (11.57 miles) long, in the Italian plan, and 18,180 metres (11.29 miles), in the Moser plan. In the approaches, however, Herr Moser has succeeded in modifying the plans so as to permit of a material reduction in the estimated cost, and in the topographical maps accompanying his paper he shows the comparative routes of the two schemes very clearly. From these it appears that the new plan for the Splügen railway and tunnel offer no difficulties greater than those successfully overcome in the St. Gotthard railway, the cost of the tunnel being somewhat greater only because of the greater length.

Herr Moser's estimate for the cost of the revised route is a total of 112,554,000 francs, a saving of more than 34,000,000 francs over the Italian route, this gain being accomplished by shortening the length of the railway by about 5 kilometres, and by reducing very materially the lengths of the shorter tunnels in the approaches.

Since the proposed Splügen route would form a portion of the same system as the Brenner and the St. Gotthard routes, it is desirable to show to what extent it could expect to share the traffic. Taking Zürich and Bale as the commercial terminals in Switzerland, and Milan in Italy, it appears that there is but little difference so far as distances go, but that there is a very material advantage in favour of the Splügen route as regards grades and elevation to be overcome, this latter amounting to more than 800 metres in favour of Splügen.

The volume of traffic to be looked for by the opening of this proposed railway cannot be deduced from Swiss sources, since the greater part of it would have to come from other countries, Switzerland profiting thus by its position as the most available highway. Whether the possible returns to be expected from this business would be sufficient to make the construction of a work of such magnitude profitable remains to be seen, but it is not improbable that before the Simplon tunnel is wholly completed, its successor at the Splügen Pass will have been commenced.

REVIEW OF THE AMERICAN PRESS

The Flow of Water in Rivers.

REFERENCE was made in these columns, in the April issue, to the recent measurements of the flow of the Niagara river in connection with the paper of Mr. Clinton W. Stewart, presented before the Western Society of Engineers. The discussion of this paper brought out some interesting features in connection with the important question of river gauging, and from the *Journal* of the society some of these points are here reviewed.

Professor J. B. Johnson showed that the velocity curves given in Mr. Stewart's paper, if carefully studied, threw light on the causes of retardation of the flow of water in channels, and called attention to the fact that the high value of the coefficient of roughness, so-called, deduced for the Kutter formula from these gaugings, indicated the small influence which the wetted perimeter exerted upon the flow, either in width, length, or character of surface. There seems to be little doubt that the great resistance to the flow of water is not the direct frictional resistance of the water against the banks and bottom of the bed. It is really due almost altogether to the resistance to internal motion, or what might be called the internal work of the water. Much of this internal work is due to the roughness of the channel, but it is an indirect influence which is thus exerted, and it is the churning up of the water that uses up the hydraulic head, and not the direct frictional resistance of the wetted perimeter.

The bottom of the Niagara river is very irregular, full of rocks and irregularities, so that the water is in a continual boil, and a similar action takes place even in rivers flowing over alluvial bottom, such as the Mississippi. These streams provide their own extraordinary resistance, moving the sand into ridges on the bottom, called sand waves, and the water becomes filled with boils and eddies as it passes over these inequalities, and thus much of the head is lost.

A notable instance of the marked influence which this internal work may exert upon flow is seen in a well-known case of a four-foot steel conduit in which a marked error in the computed flow occurred because sufficient account was not taken of the internal motion caused by the rivet heads and the lapping of the plates. It is by no means enough to assume that the area is diminished by the deduction of an annular ring included by a circle taken inside of the rivet heads, since the eddies and swirls formed in the water by the projections absorb much more of the head than corresponds to such a reduced section. Engineers should keep their minds centered on the fact that the loss of head is mainly due to the internal work of the water, and that anything which adds to this internal work deducts very greatly from the available head.

It is this vortex motion of the water which makes it difficult to obtain reliable results with current meters, since there is not a uniform velocity at any point in the section, but a mixture of continually varying velocities, the average of which it is sought to obtain. This point was well brought out in the discussion by Mr. J. A. Seddon, who said: "There is no such thing as continuous lineral motion of water in rivers. Every actual slope line is a line of uniform acceleration which runs into a whirl, and that is the end of it. With the known viscosity of water, there is no other way in which a resistance can be developed that will balance the motion, and it does that in the flow simply by holding it between oscillating extremes, like the balance wheel of a watch or a regulating pendulum. In the flow, then, practically all the energy of the discharge and fall simply passes into vortex motions, just as it does in the drop over Niagara, only in the river this action is in general distributed and intermittent."

The meter, therefore, has not only to face the general drift in the direction of the flow, but has also a stream of whirls and eddies thrashing through it. Since current meters are generally calibrated or rated in still water, or at least in a continuous and uniform current, it would seem as if the changed conditions existing in a rapidly running stream might account for many of the discrepancies which are found to occur. It is advisable to use more than one method, wherever possible, in order that any serious error may be revealed by the discrepancy. The rod float is perhaps as liable to error as a meter, but if measurements by both methods agree fairly well there is a confidence felt in the result which must be greater than that due to the same substantial agreement of two meters.

When the important consequences which depend upon reliable measurements of flow of water are considered, there is every reason to encourage such discussions as that which Mr. Stewart's paper elicited and to give them such publicity as the importance of the questions warrant.

The Power Consumption of Automobiles.

Last year a paper was presented before the American Institute of Electrical Engineers by Messrs. Sever and Fliess upon the comparative cost of operating delivery wagons in cities by electricity, as compared with horses. This paper was reviewed in these columns in the issue of September, 1899, and now we have an account of the continuance of the investigations upon which the conclusions were based, in the form of a paper by Professor George F. Sever, in a recent issue of the *Electrical Review*.

Up to the time of the presentation of the first-mentioned paper there had been little information of an authoritative nature available upon the coat of either horse or electric service, and hence it was necessary to determine the cost of horse operation in order to procure the basis for comparison. Later experience had confirmed the practical accuracy of the figures obtained by the first investigation, which are substantially as follows:

"Total cost of 1 wagon, 1 horse, wages and attendance per day, equals 364.83 cents, of which 64.61 cents, or 17.7 per cent., is chargeable to the horse, 14.52 cents, or 3.98 per cent., is chargeable to the wagon, and 285.7 cents, or 78.32 per cent., is required for the wages of the driver and his helper.

"The total weight to be moved is 2,075 pounds, or approximately one ton, 500 pounds of this being considered the weight of the load to be delivered. In this service each wagon covers 21 miles per day, so that the cost per ton-mile, which is the unit of comparison, would be 364.83 : 21, or 17.373 cents."

Similar computations for a two-horse wagon, intended to cover twice the distance, give a cost of 10.2 cents per ton-mile. Having these data for the horse-drawn wagons, comparison may be made with the electric vehicles. Tests made in New York of a large variety of vehicles of different kinds on various pavements, gave an averager of 120 watt-hours per ton-mile, or 0.156 horse-power hours per ton-mile, as the expenditure of electrical energy, in such service. Of course it is necessary to provide a larger capacity than this, both for starting, and to meet the demands of heavy grades, while the minimum power shown in any of the tests was 81 watt-hours per ton-mile.

Taking the speed of the electric vehicle at 9 miles per hour, the 42 miles would be covered in 4.66 hours, and if the cost per kilowatt hour be taken at 5 cents, the cost for power would be 71.28 cents, the power consumption being 120 watt-hours per ton-mile. Taking in the charges for interest on wagon, stable rent, and wages, the total cost for operating comes out 404.26 cents, there being thus a saving of 24.28 cents per day under these conditions.

An important point in this connection is the greater weight of the electric vehicle, the total weight for a load capacity of 500 pounds being 2.263 tons. It is, of course, important that every effort should be made to reduce the weight of the wagon, in order to increase the ratio of load delivered to the total weight, and thus reduce the total power cost.

A fairer manner of comparing the power costs is to eliminate in both cases the fixed wages for driver and helper, when it is found that the cost of the horse forms 90 per cent. of the operating costs in that service, while the cost of power in the electric service is only 60 per cent. The actual saving is naturally the same, *i. e.*, 24.28 cents per day, but this is a saving of 17 per cent. over horse operation.

It is not practicable to fix any reliable figures for depreciation, since the apparatus is too new to afford data as to its life.

The depreciation should not be large, so far as the motors and running parts are concerned, but a depreciation factor of 20 per cent. should be allowed for the battery.

"That the differences shown are not larger is due to the fact that in making the comparisons, the lowest average cost for horse service has been taken and the highest cost for electric service has been placed against this. With cheaper power a further reduction can readily be made in the operative costs and a better showing made for the electric service. It can be pointed out that if the schedule speed of the automobiles can be raised, the wagons can cover much more territory per day, and therefore reduce the percentage that the employees' wages are of the total. This is a similar condition to that which exists in electric railway operation, and many of the same operative details that now control railway work can be successfully applied to electric delivery service."

When the experience which has been gained in the practical operation of electric street railways is considered, there is every reason to believe that many economies may be anticipated in the use of electric vehicles for delivery service, while the horse service has doubtless reached its best long ago.

The Action of Water on Asphalt.

ALTHOUGH asphalt is mainly used for the construction of pavements, it is coming into use for various other purposes, and of late it has been employed in many places for lining the reservoirs of water works. For several reasons it is well adapted for this purpose, as by its use a smooth, clean lining may be obtained at a moderate cost, and almost perfect tightness against leakage, and in fact, reservoirs which have given much trouble from leakage have been made satisfactorily tight by giving them asphalt linings.

It has naturally been assumed that the asphalt was unaffected by contact with the water, but in a paper recently presented before the Engineers' Club of Brooklyn by George C. Whipple and Daniel D. Jackson, and published in *Engineering News*, the results of a number of experiments are given, which in some cases seem to prove the contrary. These tests were conducted at the Mount Prospect Laboratory of the Brooklyn water works, and covered a period of about two years, so that there is every reason to believe that the conditions in actual practice were repeated. In the case of pavements the asphalt is intermittently subject to the action of water during rains and washings, and in winter it may be for a long time in contact with snow and ice. In the case of reservoir linings the asphalt is alternately wet and dry at and near the water line, and is also exposed to the erosive action of the waves and force of the ice in winter. Below the water line it is in continual contact with the water, and at the bottom of the reservoir the added action of pressure due the weight of the water must be considered.

Seventeen specimens of asphalt were investigated, these including the varieties generally used for paving, but not including the rock asphalts. The experiments were conducted along three lines: First, that of placing samples of the asphalts in contact with water in glass jars and subsequently noting the change in the analysis of the water, thereby ascertaining the nature of the soluble constituents of the asphalts. Second, that of immersing samples of the asphalts in water under various conditions and noting their change in weight. Third, that of observing the action of water upon the asphalts by noting changes in their physical condition. Both distilled and surface waters were used, so that any difference in action might be observed, if such existed.

The investigations revealed a wide difference in the behavior of the different varieties, and the results should have much influence upon the selection of asphalt for reservoir linings. In some cases there was a change in color from black to brown, the asphalt being converted into a soft, punky material, covered with cracks and pits, this action appearing in the Trinidad asphalt, and to a lesser degree and more slowly in the Bermudez asphalt. In the various grades of Alcatraz asphalt a similar action took place, varying in extent, however, and being but slight in some cases. In the hard Cuban asphalt there was practically no change, while in the Assyrian asphalt, but one grade, No. 5, showed any material action. The details of these actions are fully given in table annexed to the paper, which should be consulted for reference. Tables are also given showing the loss after a period of two years' immersion, together with the results of the analyses of the waters in which they were immersed.

The cause of the action of water upon asphalt appears to be in part chemical and in part physical, and according to Richardson, the molecular structure of the asphalts is an important consideration. A certain amount of water is absorbed physically, as shown by an increase in weight, and the brown punky material will lose weight on drying. Throughout the course of the investigations it was observed that the waters which contained the smallest amount of mineral matter produced the greatest action upon the asphalts. Sea water gave but little action, while the most marked effect was produced by distilled water. A determination of the amount of dissolved oxygen in the distilled water, sea water, and brine gave the following results in cubic centimeters of dissolved oxygen per liter: Distilled water, 7.1; sea water, 4.8; brine, 0.6.

These facts show conclusively that the action of water upon asphalt is largely one of oxidation and is due to the oxygen dissolved in the water. As a final test, however, a sample of Trinidad asphalt was covered with water which had been boiled until free from oxygen, and then tightly sealed to prevent absorption from the air. The action that took place under these conditions was very slight. It appears, therefore, that water acts chiefly as a carrier of oxygen and does not to any extent give up the oxygen of its own composition.

A practical example of the behavior of asphalt in actual service as a reservoir lining is given in the case of the reservoirs at Denver, Col., one of which was lined with Trinidad asphalt and one with California asphalt in 1891-1892, both of which have become very unsatisfactory in condition by cause of the action of the water.

A Water-Distilling Plant.

The experience with the use of salt water in the boilers of naval vessels during the Spanish-American war has led the government to provide increased facilities for the supply of pure distilled water to vessels at various points, as well as the construction of distilling ships to accompany naval squadrons on cruises.

A very interesting account of the test of the new distilling plant recently erected at Dry Tortugas, off the coast of Florida, is given in a paper by Lieutenant R. K. Crank, U. S. N., in a recent issue of the *Journal of the American Society of Naval Engineers,* from which some abstracts are here made.

The apparatus used at this station is constructed upon the same principle as that employed in the manufacture of sugar, and in fact the evaporators are "triple-effect" sugar evaporators applied to the distillation of water without material change in construction or operation.

"The method followed in this 'multiple-effect' system is, briefly, as follows: The sea water to be evaporated is first passed through heaters which are supplied with steam from the boilers or from the pressure-reducing tank. The temperature of the sea water is raised to about 300 degrees or more in the heaters. The heated sea water then passes to a pressure-reducing tank, in which a pressure of from 10 to 15 pounds is maintained. A portion of the water becomes steam on account of the low pressure and high temperature. The exhaust steam from all the auxiliary machinery of the plant also goes into this tank. The steam from the pressure-reducing tank is almost all employed to heat the first heater through which the sea water is passed. The unevaporated portion of the sea water in the tank then goes into the first effect (or evaporator), passing first through a centrifugal circulating pump, by which it is showered over the outside of the evaporating tubes. Live steam from the boilers, supplemented by steam from the pressure-reducing tank, is admitted to the inside of the evaporating tubes. A portion of the sea water is converted into steam; this steam passes into the evaporating tubes of the next lower effect, where it aids in evaporating the salt water in that effect. The unevaporated portion of the sea water falls to the bottom of the first effect, whence it is drawn by the centrifugal pump and again showered over the evaporating tubes of this effect, the loss from evaporating being automatically supplied, through a float valve, by fresh feed from the pressure-reducing tank. This action is continued in each of the effects, the constantly moving sea water increasing in density as it passes in turn through the effects. In the last effect, the brine is drawn off at any desired density at a temperature corresponding to the very low pressure (below atmospheric pressure) maintained in this effect. In an ordinary 'single-effect' evaporator, such as is used aboard ship, the brine is blown off at a comparatively high temperature and much heat is wasted."

It will be seen from the above description that every effort is made to utilize the heat to the best effect, and as a consequence a very efficient performance should result, and it was to ascertain the effective performance that the test was made.

The plant was installed to produce 60,000 U. S. gallons of distilled water every 24 hours from sea water, for six days of each week, allowing one day out of each week for cleaning. The test was therefore made of six days' duration, rendering both the capacity and economy to be determined.

The data and results of the test are tabulated very fully in the paper, to which reference must be made for details, as well as for illustrations of the various points of construction.

The total amount of water distilled in the six days was 548,418 gallons, of which 193,856 gallons were used to feed the boilers, giving a net output of 59,260 gallons per day, or practically the amount required, and the economy of the apparatus was such that 21.58 pounds of water were distilled per pound of coal for the gross output, or deducting for the water supplied to the boilers, each pound of coal produced 13.98 pounds net of pure water.

In order to show the high degree of efficency which is thus attained, Lieutenant Crank gives a computation showing the theoretical maximum evaporation possible by this sysytem to be 23.6 pounds of fresh water per pound of coal, while as above stated, the actual output of the plant at Dry Tortugas was more than 21½ pounds, a most satisfactory result.

An interesting feature of the apparatus is the method proposed for cleaning. After the six days' run it was found that there was only a light scale on the tubes of the heaters, varying from 1-64 in the first to 3-64 in the third. The tubes of the first and second effects were practically clean. In the third effect the incrustation was 5-16 thick. This scale is removed by running a solution of carbonate of soda through the heaters and effects, which acts on the insoluble scale, forming soluble sulphate of soda and carbonate of lime. A dilute solution of hydrochloric acid is then run through, acting upon the remaining carbonate of lime, and completing the cleaning process, this operation being performed every seventh day. Since no portion of the heating surface is exposed to intense heat there is no baking of scale, and it is believed that this method of cleaning will prove effective, although it will require time for its action to be demonstrated.

The Performance of Slow Sand Filters.

SEVERAL months ago the account of the large filtration plant installed at Albany, N. Y., was described in these columns, in connection with the paper presented before the American Society of Civil Engineers by its designer, Mr. Allen Hazen, and now we have as a part of the discussion upon that paper some valuable data in regard to the performance of this, the largest slow sand filtration plant in the United States.

The most important fact, next to those relating to the bacteria efficiency of the filters, are those relating to the cost of filtering the water, and from the discussion of Mr. George I. Bailey, the superintendent of the water works, some definite costs are obtained.

The general figures are given, from which a summary is made, showing that for a period of 118 days the cost of operation of the works was $6,614.94, during which time 1,470,000,0000 gallons were pumped and filtered, making a cost of $4.19 per million gallons. The cost of pumping alone is given as $2.52 per million gallons, leaving $1.67 as the cost of operating the filters, including laboratory work. The cost of scraping, wheeling out, washing and replacing sand, for the actual number of hours, exclusive of superintendence, laboratory work, lost time, tools, etc., is $1.19 per million gallons treated.

So far as bacterial efficiency is concerned, the filter has given excellent results. The weekly averages of the bacteria in the unfiltered water ranged from 4,733 to 66,000 per cubic centimeter, and the percentage of removal ranged from 94.8 to 99.7; the former figure was exceptionally low, the next lowest being 97.8.

The brief period during which the Albany filters have been in operation is not sufficient to show exactly the degree to which the purification of the Hudson River water will ultimately attain, but the results already obtained are excellent and should show improvement hereafter.

While slow sand filtration can be depended upon to remove nearly all pathogenic bacteria, it will not remove all coloring matter from the water. This is not a matter which the experts consider serious, but the ordinary consumer cannot understand why the filtered water should not be colorless. Experiments have shown that simple sand filtration is not capable of removing more than about one-half of the coloring matter from water, under favorable conditions, and that ordinarily the amount of reduction is not more than one-third or one-fourth.

Odors are also difficult to remove. It has been found at Albany that sand filtration is not always effective in removing certain odors from the water. The odor imparted to the water by the waste material discharged from the gas works, and which is not removed by the filters, has caused complaint from the consumers. This is undoubtedly an objection, and since it has been shown that filtration will not remove it, some precautions should be taken to prevent such discharges from getting into the stream, and since the source can readily be determined, there should be no difficulty in applying preventive measures. The progress which has been made in the application of methods for the purification of sewage and factory refuse has been such during the past decade that there is now little or no reason why all distinctly injurious matter of which the origin may be traced, should not be treated before it is permitted to be discharged into any stream which is subsequently used for water supply.

The Albany filters are covered, but the reservoir for the storage of the filtered water is open, and it is a matter of interest to biologists to observe the extent to which the water will be affected by the appearance of algæ growths. It has generally been observed that ground waters, when exposed to light, are liable to deterioration from this cause, but the reservoir at Albany has hardly been in use long enough to determine whether or not any serious inconvenience will result from this cause.

Altogether the general results which have been obtained thus far from the operation of the Albany filters, the largest which have as yet been put into operation in the United States, are decidedly encouraging effective method of purification used to securing a pure water supply is concerned. Many great cities have definitely come to the conclusion that an original pure water supply cannot be secured or maintained, and the general opinion is that such supply as is available must be secured, and some effective method of purification used to secure a satisfactory quality. In view of this conclusion the experience of Albany is most important and instructive, and should lead to many similar installations in places where there has until now been hesitation and doubt.

The Verification of Electrical Standards.

A STANDARD of measurement is of little value unless some authoritative method of verification which shall be acceptable to all users is provided, and in fact, without some such source of verification it soon ceases to become a standard. In Germany the Imperial Physico-Technical Reichsaustalt is accepted at the ultimate bureau of verification, while in England the standards of the British Association are accepted, and in the United States the Bureau of Weights and Measures is endeavoring to do what is necessary within the range of its many limitations.

An article in a recent issue of the *Electrical World and Engineer* by Dr. Frank A. Wolff, Jr., discusses the facilities afforded by the Office of Standard Weights and Measures for the verification of electrical standards and electrical measuring apparatus in the United States, and in connection with this subject he gives some account of the history of the units of reference employed.

At first all standards of quantity and value were arbitrary and crude, but Gauss and Weber solved the general problem by defining all units in the terms of the mechanical actions to which they give rise. Since all mechanical units can be expressed in terms of three independent fundamental units, such as those of length, mass, and time, the magnetic and electrical units of Gauss and Weber are thus expressible in terms of the same fundamental units, and are therefore entirely independent of the physical properties of arbitrarily chosen substances. Hence they are called absolute units, their magnitudes depending wholly on the choice of the fundamental units.

The units of length and mass selected were usually multiples or submultiples of the corresponding metric units, the centimeter, gramme, and second having now been universally adopted, the derived units being known as the C. G. S. units.

Dr. Wolff proceeds to describe some of the arbitrary standards of electrical resistance, such as that of Jacobi, consisting of the resistance of a certain piece of wire, of which a number of copies were made; this was followed by the standard of Dr. Werner Siemens, which was the resistance, at 0° C., of a column of mercury, 1 square millimeter in cross section, and 1 meter in length. He then goes on to show that while the C. G. S. system is theoretically the true one, yet in actual practice it has many inconveniences, and while it should be used in laboratories of reference and verification, it may be replaced by the resistance of a definite portion of a definite substance. The principal difficulty in this respect is that of securing uniformity in chemical and physical character of the material, the resistance being affected very materially by slight differences in these respects.

Various attempts were made to secure a standard of some concrete nature, and from the time of the first international electrical congress in Paris in 1881 down to the meeting at the World's Fair in Chicago, in 1893, the subject was under discussion and revision.

At the latter time it was officially decided to adopt as the unit of resistance the mean of all the best determinations, the resistance at 0° C. of a column of mercury 106.3 centimeters in length, and having a mass of 14.4521 grammes. The unit of resistance and the other electrical units defined by the international congress were legalized in the United States by act of Congress in 1894, and have also been legalized in the other countries represented.

The apparatus used in making comparisons and determining the errors of standards is described very fully by Dr. Wolff, as well as the method of operation. An example of the work is given by a detailed comparison, showing the closeness with which a number of independent measurements agree.

The unit of electromotive force, the volt, was legally defined to be $\frac{1000}{1434}$ of the electromotive force of a Clark standard cell at 15° C. Since the standard cells which have been made for purposes of comparison agree within plus or minus .005 per cent. it will be seen that this is very satisfactory.

According to Ohm's law the standard of electrical current should be determinable from the ratio of the electromotive force to the resistance, and the international congress made a grave mistake in attempting to define three units when the third could be derived from the previous two. Instead of deducing the standard of current from the electromotive force and the resistance, it was defined by the electrochemical equivalent of silver. Current may, however, be consistently measured by the fall in potential in terms of specified standards of resistance.

While the Office of Weights and Measures is prepared to make comparisons of all these standards within moderate limits, its facilities need widening in view of the great extension of the practical applications of electricity. The facilities are inadequate for the measurement of such quantities as potential differences up to 20,000 volts, and currents of 20,000 amperes, and yet such magnitudes are met with to-day in actual practice. Facilities are also required for the verification of alternating current apparatus, and for photometry, as well as the measurement of high and low temperatures, and with the increasing importance of all these determinations in the arts it is to be hoped that this necessary portion of government work will receive the means and support which its industrial value demands.

Sewer Ventilation.

In a valuable paper upon the subject of sewers by Mr. A. Prescott Folwell in a recent issue of the *Engineering Record* some interesting points are brought out.

"The average citizen thinks of sewer air as something which is invariably connected with the public sewers only; and if there is a good main trap in the house connection, and a few manholes with perforated covers are placed along the line of the sewer, no further thought is given to the sewer air."

Although this view does not apply to engineers who have given sanitation attention, yet there is a difference of opinion among experts as to the proper method of ventilation, and hence a comparison is made of the practice in various cities.

An examination of the sources of air pollution shows that the most favorable conditions for its production are in the soil pipes and house connections, so that trapping these off from the main sewer will not prevent the poisoned air from entering the building. The aim should therefore be not only to exclude from buildings the sewer air but also the air from their own piping. Attempts have been made to use forced ventilation, but with the exception of the Liernur system, in which the outlets are tightly sealed, these have not been successful.

"With sewers and house connections as now constructed, the only practicable plan seems to be that of providing the greatest freedom of air circulation in both sewer and connected pipes. Open channels for these would afford the freest ventilation, but this construction is objectionable for several reasons, and the nearest approach possible seems to be to provide the maximum number of connections between the sewer and the outer air. One means to this end is the construction of numerous manholes with perforated covers. If the street-water enters the sewer, the inlets can also be used for this purpose if no traps be placed in the pipes connecting them with the sewer. Sewers carrying house-sewage can be ventilated through the house soil-pipes if the running or main traps be omitted, or through pipes leading from below the main traps and extending above the roofs of the buildings. If a sufficient number of these and other outlets are provided, continuous circulation of air is caused by difference of temperature between the sewer air and that outside, by wind blowing by or into the openings, by fluctuations in the volume of the sewage, which increases or decreases the total air space in the sewers, by the friction of the flowing sewage upon the air, and by other minor causes. Special inlet or outlet pipes placed along the curb or elsewhere are seldom other than beneficial, but cannot be relied on to act always as either inlet or outlet alone, and are probably not more beneficial than untrapped soil pipes of the same size; and if it can be shown that untrapped house and inlet connections, combined with ventilating manholes, furnish ample ventilation for sewers, and that such use of them is not objectionable, the construction of special ventilation devices would seem to be a needless expense and complication."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*. a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Bridges. *m.* Chicago.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.

Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago, U. S. A.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Accidents.

The Owner's Liability for Building Accidents. A statement of the law as interpreted in New York, where the owner of a building which collapsed with fatal results has been held liable for damages. 600 w. Eng Rec—March 10, 1900. No. 32954.

American Architecture.

American Architecture from a Foreign Point of View: New York City. Jean Schopfer. An illustrated article giving the effect produced by New York City on the mind of a European observer. 4500 w. Archt Rev—March, 1900. No. 33189 D.

Angles.

The Exterior Treatment of Sharp or Acute Angles in Street Building. A. W. Hennings. Read before the British Archt. Assn. Discusses the design of buildings to fit angular sites, when the land is valuable, considering special features, and giving many illustrations. Discussion. 6300 w. Builder—March 3, 1900. No. 32989 A.

Clay.

Clay Material as Used in the Best Modern Buildings. William D. Gates. On the improvement made in this material, its use and adaptability. Ill. 1000 w. Cal Arch't—Feb., 1900. No. 33171 C.

Dwellings.

Working Class Dwellings in Blocks. Thomas Blashill. Read before the British Archt. Assn. Discusses designs carried out by the London County Council, and the difficulties in the problem. Also general discussion. 9000 w. Builder—Feb. 17, 1900. No. 32867 A.

Glass.

Plate Glass. C. W. Brown. Brief review of the history of this industry, the manufacture and use. 2000 w. Jour of Pro of Am Inst of Archts—1899. No. 33140 D.

Hospitals.

Axioms and Principles of Modern Hospital Construction. Max Junghaendel. Read before the Technical Soc. of the Pacific Coast. A discussion of hospital construction and sanitation. 6200 w. Am Arch—March 10, 1900. No. 32931.

House-Building.

In the Cause of Intelligent House-Building. Suggestions for the improvement of building construction, the securing of better ventilation, and other details. 2000 w. Jour Gas Lgt—Feb. 20, 1900. No. 32822 A.

Library.

The John Ryland's Library, Manchester. Basil Champneys. Illustrated description of a building founded on English types. Also discussion. 5000 w. Jour Roy Inst of Brit Archts—Jan. 27, 1900. No. 32879 B.

Steel Skeleton.

The Steel Skeleton, or the Modern Sky-Scrapers. W. L. B. Jenney. Illustrated discussion of the engineering problems. 6400 w. Cal Arch't—Feb., 1900. No. 33168 C.

Tenements.

Model Tenements. Illustrated description of the plans which received the first prize in a competition held by the Charity Organization Society of New York. 1200 w. Eng Rec—March 3, 1900. No. 32811.

HEATING AND VENTILATION.

Condensation.

Pipes for Water of Condensation in Low-Pressure Steam Heating Apparatus (Die Kondenswasserableitung bei Niederdruck Dampfheizungen). With computations for the amount of water discharged, and the methods of providing for its return or removal. 2500 w. Gesundheits-Ingenieur—Feb. 28, 1900. No. 33254 B.

Cooling Dwellings.

Residence Cooling in St. Louis. Alfred Siebert. Describes method used by the writer. 600 w. Ice & Refrig—March, 1900. No. 32895 C.

The Refrigeration of Dwellings. E. Brueckner. Considers the cost and value, the systems, and scientific principles on which to calculate the amount required. 3500 w. Ice & Refrig—March, 1900. No. 32894 C.

Fireproofing.

Development of the Fireproofing of Buildings. Peter B. Wight. An illustrated review of the development of fireproof construction. 3300 w. Cal Arch't —Feb., 1900. No. 33169 C.

Hot-Water.

An Unusual Position for an Expansion Tank. Illustrated explanation of a hot-water heating system with a novel expansion tank in the cellar of the building below all the radiators. 1000 w. Eng Rec—March 17, 1900. No. 33051.

Manual of Steam and Hot-Water Heating. Thomas E. M'Neill. A detailed study of these systems. Ill. 1500 w. Met Work—March 17, 1900. Serial. 1st part. No. 33066.

Low Pressure.

Boilers for Low Pressure Hot Water Heating. Samuel Naylor. Read at meeting of the Inst. of Heat. and Ven. Engs., London. Discusses the important features necessary in the selection of boilers, giving results obtained with different kinds. 3400 w. Plumb & Dec—March 1, 1900. No. 32986 A.

Modern Methods.

Modern Methods of Heating and Ventilating Buildings as Practiced in the United States. James J. Lawler. Discusses methods in the use of steam and hot water. Ill. 3000 w. Cal Arch't—Feb., 1900. No. 33173 C.

Paris Exposition.

Metal Work Details of the Paris Exposition Buildings, Paris. Illustrated account of the general features of the grounds and the steel framing of the Palace of Civil Engineering and Transportation; explains the erection methods. 1500 w. Eng Rec—March 17, 1900. Serial. 1st part. No. 33050.

Notes on the Palaces of the Paris Exhibition, 1900. Charles Lucas. Exposisition of works in course of completion, with illustrations and brief discussion. Both in French and English. 7500 w. Jour Roy Inst of Brit Archts—Feb. 24, 1900. No. 33079 B.

Schoolhouses.

Heating and Ventilating of Schoolhouses. R. C. Carpenter. A description of some of the methods employed, with suggestions for proportioning and constructing such systems. Ill. 6600 w. Br Build—March, 1900. No. 33166 D.

School Ventilating and Heating Apparatus. Review of a report by Alfred R. Wolff, describing the bad features in a high-school he examined, and giving his recommendations for their removal. 1500 w. Eng Rec—March 24, 1900. No. 33129.

Steam.

Heating by Steam at or Below Atmospheric Pressure. D. M. Nesbit. Read at meeting of the Inst. of Heat. and Ven. Engs., London. Discusses atmospheric steam heating, exhaust steam, etc. 2800 w. Plumb & Dec—March 1, 1900. No. 32987 A.

Piping for Steam Heating. A discussion by W. H. Bryan and W. S. Monroe on the methods of selecting pipe sizes. 1700 w. Eng Rec—March 17, 1900. No. 33052.

PLUMBING AND GASFITTING.

Residence.

Plumbing in Fifth Avenue Residences, New York. Illustrated description of the work in houses of the Astor estate, where the highest grade of work was required. 1200 w. Eng Rec—March 10, 1900. No. 32966.

Stables.

Stables on the Stern Country Estate. Illustrates and describes the arrangement of the farm buildings and horse stables on a large Tarrytown estate. 2500 w. Eng Rec—March 10, 1900. No. 32965.

MISCELLANY.

Electro-Mechanics.

Electrical Engineering for Architects. Arthur Vaughan Abbott. Considers the proper manner of introducing electricity, the uses to which it may be applied, and the safeguards which should be observed in its installation. 4500 w. Cal Arch't—Feb., 1900. 33172 C.

Landscape Architecture.

The Harvard Course in Landscape Architecture. An outline of the studies to be pursued in the first course of the kind established in the United States. 1000 w. Eng Rec—March 24, 1900. No. 33128.

Metal-Work.

Ornamental Metal Work. W. W. Kent. On the design, manufacture, and use of this material. Ill. 2800 w. Cal Arch't—Feb., 1900. No. 33174 C.

Office Methods.

The Office Methods of H. H. Richardson. Describes an architect's system of directing design without making sketches himself. 800 w. Eng Rec—March 3, 1900. No. 32810.

CIVIL ENGINEERING

BRIDGES.

Alexander III.

The Alexander III. Bridge, Paris. J. Guenaire. Illustrated description of this handsome bridge and its construction. 1800 w. Sci Am—March 10, 1900. No. 32924.

Arch.

Hinged Concrete Arch Bridge Over the Neckar River at Kirchheim, Wurtemberg. General view with brief description of a notable highway bridge of this type. 250 w. Eng News—March 29, 1900. No. 33190.

The Two-Hinged Arch. A discussion of the advantages of this type, with some comparisons with the three-hinged arch. 2000 w. Engr, London—Feb. 16, 1900. No. 32797 A.

Atbara.

An American Bridge in the Soudan (Eine Amerikanische Brücke im Sudan). F. C. Kunz. A general description of the Atbara bridge, by one of the engineers of the Pencoyd Iron Works, with numerous interesting photographs of the erection of the structure. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 23, 1900. No. 33236 B.

Davenport Bridge.

The Latest of the Large Mississippi Bridges. Illustrated description of a bridge of seven fixed spans and a draw span, having a total length of 2,310 feet. 700 w. Sci Am—March 17, 1900. No. 33009.

Deformation.

Two Instruments for Measuring Deformation and Stresses in Bridges (Zwei Instrumente für Messungen von Formanderung und Spannungen au Brücken). G. Mantel. Describing an adjustable clinometer and an extensometer for use in quantitative measurements of flexure and tension in framed structures. Three articles. 4000 w. Schweizerische Bauzeitung—Feb. 3, 10, 17, 1900. No. 33244 each B.

East River Bridge.

Falsework for Erecting the Manhattan Towers and End Spans, New East River Bridge. C. E. Fowler. Illustrated description with two-page plate of details. 3000 w. Eng News—March 8, 1900. No. 32940.

Expansion Bearing.

The Simple Rocker as a Substitute for the Roller Bearing (Das Einfache Pendel als Ersatz für das Rollen Kipplager). H. Kübler. A discussion of the use of a single rocker instead of a series of rollers as an expansion bearing for bridge trusses; with computations applied to a practical example. 1000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33221 D.

Ferry Bridges.

Transfer Bridges. Illustrated descriptions of a suspended ferry, with a statement of its advantages. These bridges are from designs of Messrs. Arnodin and Palacio. 2300 w. Engng—Feb. 23, 1900. Serial. 1st part. No. 32869 A.

Foot-Bridge.

The Metal Foot-Bridge at Oberschönweide (La Passerelle Métallique d'Oberschönweide). An illustrated description of the new bridge over the Spree at Oberschönweide near Berlin. 1800 w. 1 plate. Génie Civil—March 3, 1900. No. 33208 D.

Foundations.

See Construction.

Lift Bridge.

Rolling Lift Bridge of the Boston Terminal (N. Y., N. H. & H. R. R.). Illustrated description of the six track draw bridge over Fort Point Channel. 3000 w. Eng News—March 15, 1900. No. 33088.

The Cuyahoga River Rolling Lift Bridge. Illustrated description of a single-track rolling bridge of 110-ft. clear span; the strains in the main and cantilever spans are given in detail. 800 w. Eng Rec—March 3, 1900. No. 32807.

Mississippi.

Temporary Bridge Across the Mississippi River, at St. Paul, Minnesota. Moving of Three 140-Foot Spans. A. W. Munster. Illustrations and brief explanation of this work. 400 w. Jour Assn of Engng Socs—Jan., 1900. No. 32835 C.

Railway Bridges.

Bridges Over the River Aire. Illustrated detailed description. 2000 w. Engr, Lond—March 9, 1900. No. 33032 A.

Bridge Work on the Baltimore & Ohio Railroad. Illustrated description of recent heavy double-track, plate-girder and truss bridges. 1000 w. Eng Rec—March 24, 1900. No. 33123.

Stresses.

Secondary Stresses in Trusses and Girders. Editorial discussion of views advanced concerning the advantages of the pin system. 1300 w. Engr, Lond—March 16, 1900. No. 33149 A.

CONSTRUCTION.

Foundations.

Improvements in Sinking Shafts (Neueres über Schachtabteufungen). P. Simons. A description of the method employed at Berne for sinking pits for the foundation piers of the Kornhaus Bridge, the Stadt-Theater, and other structures. 1200 w. Schweizerische Bauzeitung—Feb. 17, 1900. No. 33245 B.

The Inter-provincial Bridge, Ottawa, Canada. Illustrated description of the methods of putting down the foundations of piers in 20 to 60 feet of water-logged saw-dust and timber; with general details of the cantilever superstructure. 2200 w. Eng Rec—March 10, 1900. No. 32956.

Madagascar.

Public Works in Madagascar (Les Travaux Public à Madagascar). A. Dumas. A full account of the highway, railway, and harbour improvements initiated by the French government; with map of the railway from Tamatave to Tananarive. 3000 w. 1 plate. Génie Civil—Feb. 24, 1900. No. 33205 D.

Masonry.

The Present Status of Engineering Knowledge Respecting Masonry Construction. David Molitor. Considers earth pressure theories, retaining walls, fixed arches, three-hinged arches, concrete and iron arches, and concrete. Ill. 12400 w. Jour Assn of Engng Socs—Jan., 1900. No. 32834 C.

Reinforced Concrete.

The Computation of Concrete-Iron Beams with Upper Ribs (Berechnung der Betoneisenträger mit Oberen Rippen). Max R. von Thullie. The mathematical computations for the particular form of Hennebique beam in which the compression member is above, and the reinforcing metal rods below. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 1900. No. 33237 B.

Roads.

Road Construction in New Jersey. A statement of the special road-work in the State during 1899, and a report of the methods of construction and repair found most satisfactory. 3000 w. Eng Rec—March 24, 1900. No. 33124.

Subway.

History of Pennsylvania Avenue Subway, Philadelphia, and Sewer Construction Connected Therewith. George S. Webster and Samuel Tobias Wagner. Presents interesting features of the history of the work of abolishing grade crossings, and the construction of connected sewers. Ill. 7500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32838 E.

Tunnels.

A Tunnel Through Quicksand. Harrison P. Eddy. An interesting, finely illustrated account of a method of tunnelling through bad ground, in Worcester, Mass. 3700 w. Jour of Worcester Poly Inst—March, 1900. No. 33020 C.

The Reconstruction of the Ronco Tunnel (Reconstruction du Tunnel de Ronco). With plate of details showing the construction of the centering and vaulting; also the mathematical computations for the earth-pressure and pressure curves in the arch. 3000 w. 1 plate. Génie Civil—Feb. 17, 1900. No. 33203 D.

HYDRAULIC AND MARINE.

Breakwaters.

Difficult Repairs to the Alderney Breakwater. B. O. Townshend. Illustrated description from Proc. Inst. C. E. of the method of inserting large concrete blocks in the face of a wall exposed to heavy seas. 1400 w. Eng Rec—March 17, 1900. No. 33048.

The Reaction Breakwater as Applied to the Improvement of Ocean Bars. Discussion of paper by Lewis M. Haupt. 2200 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32840 E.

Canals.

A Comparison of the Isthmian Canal Projects. George A. Burt. A careful review of both the Panama and Nicaragua plans, showing clearly their relative advantages, difficulties and costs. 3500 w. Engineering Magazine—April, 1900. No. 33294 B.

American Railroads and Canals. Editorial on the position of New York State in relation to the transportation trade, and the competition of other American ports and of the Canadian canals and Montreal. 1700 w. Engng—Feb. 16, 1900. No. 32795 A.

The Improvement of a Portion of the Jordan Level of the Erie Canal. Discussion of paper by William B. Landreth. 2200 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32843 E.

New York and Its Canals. Editorial on the Commissioner's report. 2000 w. Engr, Lond—Feb. 16, 1900. No. 32799 A.

New York's Canal Problem. William G. Raymond. A discussion of the report of the advisory committee appointed by the governor. 3300 w. R R Gaz—March 2, 1900. Serial. 1st part. No. 32770.

Santa Ana Canal. J. B. Lippincott. Extract from Report of the U. S. Geol. Survey. Illustrated detailed description of this canal and the water resources of southern California. 4200 w. Sci Am Sup—March 10, 1900. Serial. 1st part. No. 32927.

The Text of Two Much-Discussed Treaties. The full text of the Hay-Pauncefote and Clayton-Bulwer treaties, with editorial comment. 4000 w. Rev of Revs—March, 1900. No. 33061 A.

Waste of Money on Erie Canal. Discusses editorially the proposal to spend large sums of money on this canal, giving historical review of past waste on this enterprise. 1100 w. Loc Engng—March, 1900. No. 32751 C.

Dam.

The Assouan Dam on the Nile. An illustrated description of the methods of construction, which involve great engineering difficulties. 2800 w. Engng—March 9, 1900 No. 33026 A.

The Goose-Neck Canyon Dam. Illustrated description of a rock-fill dam 210-ft high, with a facing of steel plates.

800 w. Eng Rec—March 10, 1900. No. 32955.

Drainage.

Progress of Drainage in New Orleans. Alfred Francis Theard. A study of the general plan as recommended in the report of the Advisory Board of Engineers, explaining the general features, and showing how far it has been carried out. Ill. 4500 w. Jour Assn of Engng Socs—Jan., 1900. No. 32836 C.

The Drainage of New Orleans. L. W. Brown. Illustrated description of the investigations made, and system adopted. 3500 w. Eng News—March 15, 1900. Serial. 1st part. No. 33090.

Dredge.

An Improved Suction and Force Dredge (Saug-und Druckbagger Neuer Konstruktion). H. v. Horn. Illustrated description of an improved dredge used in Haarlem, Holland. The spoil may be delivered to the shore or scow under pressure. 800 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33222 D.

A 6-Cubic Yard Dipper Dredge for Use on the Great Lakes. Brief illustrated description. 900 w. Eng News—March 1, 1900. No. 32763.

Filtration.

Filtration Plant for the Albany Water Supply. Illustrated description of this plant, designed and erected for the removal of typhoid bacteria. 2200 w. Sci Am—March 24, 1900. No. 33093.

The Albany Water Filtration Plant. Discussion of paper by Allen Hazen. 11500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32839 E.

The Efficiency of Mechanical Filtration. A review of recent criticisms of the operation of a mechanical filter in East Providence, R. I. 2000 w. Eng Rec—March 10, 1900. No. 32959.

Flow.

Experiments on the Flow of Water in the Six-Foot Steel and Wood Pipe Line of the Pioneer Electric Power Company, at Ogden, Utah. Second Series. Charles D. Marx, Charles B. Wing, and Leander M. Hoskins. Illustrated description of apparatus and methods used in experimental investigations, giving results. 5800 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32837 E.

New Hydraulic Data. A note on the importance of experiments on the flow of water in pipes, as affording a criterion for estimating the reliability of pipe formulas. 700 w. Eng Rec—March 10, 1900. No. 32953.

Ghent.

The Maritime Installation of the Port of Ghent (Les Installations Maritimes du Port de Gand). G. Leugny. A detailed account of the Terneuzen Canal, by which communication is to be made between Ghent and the North Sea by way of the Scheldt. 2000 w. Revue Technique—Feb. 10, 1900. No. 33213 D.

Great Lakes.

Proposed Plans for Regulating Works for Controlling the Level of Lake Erie. An illustrated description of the proposed design for the regulating works, with editorial discussion of the effect upon the levels of the St. Lawrence River. 4200 w. Eng News—March 22, 1900. No. 33119.

Ground Water.

The Danger of Ground-Water Supplies in the Tropics. Eug. Ackermann. A letter from the chief sanitary engineer of Para on the well water of Brazil and its pollution. 800 w. Eng Rec—March 3, 1900. No. 32812.

The Theory of Wells (La Theorie des Puits). L. Brouhon. A mathematical investigation of the laws of infiltration of ground water into wells, with the conditions governing flow and levels. 5000 w. 2 plates. Rev Univ des Mines—Feb., 1900. No. 33288 G.

Hydrometry.

A New Method for the Graphical Treatment of Hydrometric Problems (Neue Methoden für die Graphische Behandlung Hydrometrischer Probleme). Karl Goebl. Showing the method of plotting the data of many observations, and deducing the mean flow from the curves thus obtained. 7500 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—March, 1900. No. 33249 G.

Laboratory.

The Hydraulic Laboratory of Cornell University. E. A. Fuertes. A brief history of this laboratory, built for the purpose of advancing hydraulic science. Ill. 5000 w. Jour N. E. Water Wks Assn—March, 1900. No. 32888 E.

Lighthouses.

Modern Lighthouse Apparatus. J. A. Purves. Illustrated descriptions of the mercury float *feu-éclair* light, and the spindle-eclipsing apparatus. 800 w. Nature—Feb. 22, 1900. No. 32784 A.

Mains.

Laying a 36-in. Water Main Under the Harlem River, New York. Brief description, with illustration, of the work of laying a main from 209th st., Manhattan, to Fordham Heights Landing. 500 w. Eng News—March 22, 1900. No. 33116.

Niagara.

Niagara Falls Industrial Number. A comprehensive, interesting, and fully illustrated account of the history, geology, fine bridges, power plants, etc., with much information concerning the utilization of the energy. 12000 w. Sci Am Sup—March 3, 1900. No. 32757.

Organisms.

On Removing Organisms from Water. Frederick S. Hollis. A discussion of these organisms and the methods of removal, with general discussion by members. 3800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32891 E.

The Method of Removing Organisms from the Water in the Distributing Reservoir of the City of Syracuse, N. Y. An account of the condition of the water and the methods used, with general discussion. 3800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32890 E.

Reservoirs.

Covered Reservoirs and Their Design. Freeman C. Coffin. Considers the reservoirs built, the design, etc., and the cost of various sizes. 2 plates. 11200 w. Jour N. E. Water Wks Assn—March, 1900. No. 32893 E.

The Attica and Delphi Covered Reservoirs. A description of two circular basins, with brick walls and concrete bottoms, both presenting valuable facts concerning water-proof masonry. 1200 w. Eng Rec—March 24, 1900. No. 33126.

The Brightwood Reservoir, Washington, D. C. Illustrated description of a 415 x 300-ft. distributing reservoir with concrete lining of unusual construction and a cast-iron gate house. 1500 w. Eng Rec—March 3, 1900. No. 32804.

River Banks.

Protecting Banks Against River Currents. Illustrates and describes the protection given the banks of the Missouri River by the use of woven willow mattresses. 600 w. Ry & Engng Rev—March 17, 1900. No. 33082.

The Protection of the Banks of Wild Streams (Uferschutz bei Wildwässern). A. Lernet. Showing the practical arrangements of fascines and stone work for the protection of mountain torrents not otherwise regulated. 1000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1900. No. 33233 B.

River Gauge.

An Electric Recording River Gauge. Illustrated description of an instrument for making a continuous record of the height of a river about half a mile from the recording station. 900 w. Eng Rec—March 10, 1900. No. 32957.

Stream Regulation.

The Regulation of a Section of the Goldbach in Gross-Otschehau (Die Regulierung einer Theilstrecke des Goldbaches in Gross-Otschehau). F. Krivanec. Describing the improvement of the slopes and protection of the banks by fascines. 3000 w. Oesterr Monatschr f d Oeffent Baudienst—March, 1900. No. 33248 G.

Water Pipe.

Vitrified Water Pipe for Hartford. A statement of the reasons for using vitrified clay pipe for a water main, rather than cast-iron pipe or an open channel. 900 w. Eng Rec—March 24, 1900. No. 33125.

Water Purification.

Test of a Multiple-Effect Distilling Plant. A report of the duty of a plant for producing daily 60,000 gals. of drinking water from salt water, used by the U. S. Navy at Dry Tortugas. 2000 w. Eng Rec—March 17, 1900. No. 33049.

Water Distilling Plant at the Dry Tortugas. Illustrated description of the large multiple-effect distilling plant erected at Fort Jefferson, on the Dry Tortugas, Fla., to furnish water for the naval station and barracks. 4500 w. Eng News—March 29, 1900. No. 33192.

Water Supply.

Nation's Water Supply and Its Effective Control. C. E. Jones. Paper read before the British Assn. of Water-Works Engs., with general discussion. On the best means of securing effective control. 7500 w. Jour Gas Lgt—Feb. 27, 1900. No. 32919 A.

Waterways.

Benjamin Franklin's Experiments on Depth of Waterways. A letter from him, describing experiments made in 1768, establishing as a fact the retarding influence of shallow depths on the passage of boats; with comments by H. Goldmark. 1300 w. Eng Rec—March 10, 1900. No. 32968.

Water Works.

The Buffalo, N. Y., Water Works. Louis H. Knapp. An illustrated general description of the works. 1800 w. Jour N. E. Water Wks Assn—March, 1900. No. 32889 E.

The Glasgow Water Works. James M. Gale. Describes the district from which the water supply is drawn, the means taken to secure it, and the works. 4500 w. Jour N. E. Water Wks Assn—March, 1900. No. 32892 E.

The Mount Royal Pumping Station, Baltimore, Md. Illustrated description of a pumping station designed by Henry Brauns, architect, and A. M. Quick, engineer, which is said to be the most elaborately constructed plant of the sort in service, its decorations being on the style of a modern high-class apartment house. 2000 w. Eng Rec—March 24, 1900. No. 33122.

The Water-Works of Bilston, England. James H. Fuertes. Illustrated description of a plant in which there are two sets of pumps, one for high-pressure and the other for low, driven by the same steam end; a concrete vaulted reservoir is also used. 2600 w. Eng Rec—March 10, 1900. No. 33046.

The Water-Works of Merthyr Tydfil. Illustrated description of works mainly noteworthy for an overflow masonry dam 84-ft. high, built of hydraulic lime concrete, being the second British structure of the kind in which this material was used. 2600 w. Eng Rec—March 10, 1900. No. 32961.

MATERIALS.

Asphalts.

The Action of Water on Asphalts. George C. Whipple and Daniel D. Jackson. Read before the Brooklyn Engineers' Club. An account of investigations undertaken to determine the relative action of water upon some of the most important asphalts, with reference to their use for reservoir lining. 4200 w. Eng News—March 22, 1900. No. 33117.

The Action of Water on Asphalt. Brief review of the investigations made by G. C. Whipple and D. D. Jackson on the influence of water of various kinds on asphaltum. 700 w. Eng Rec—March 17, 1900. No. 33042.

Cements.

Hydraulic Cements. William S. MacHarg. A review of the manufacture, uses, successes and failures. 2500 w. Cal Arch't—Feb., 1900. No. 33170 C.

The Testing of Cement by Filtration (Essais des Cements par Filtration). M. L. Deval. An attempt to determine the value of cement for marine construction by testing for filtration of sea water through the specimen under pressure. The difficulty in obtaining comparable results appears to be great. 2000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33241 G.

Concrete.

The Computation of Concrete Footings for Walls and Columns. Abstract of an article by George H. Blagrove, in the *Contract Journal*, of London, Eng. 1100 w. Eng News—March 8, 1900. No. 32942.

Elastic Line.

Application of the Equations of the Elastic Line (Ermittlung der Gleichungen der Elastischen Linien). Professor Ramisch. A mathematical treatment of the application of the elastic theory to a beam of uniform cross section resting upon two supports and bearing loads at definite points. 1200 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 9, 1900. No. 33234 B.

Metal Protection.

Experiments on the Protection of Steel and Aluminum Exposed to Water. Discussion of paper by A. H. Sabin. 1800 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32842 E.

Timber.

Engineering Timber. R. Phillips. Read before the Gloucester Engng. Soc. Interesting information about various kinds of timber. 2500 w. Arch, Lond—Feb. 16, 1900. No. 32819 A.

MEASUREMENT.

Reconnoissance.

Methods of Determination of Latitude, Longitude and Solar Time in Reconnoissance Surveys. William S. Post. A compilation of methods, formulas, and references found useful in this work. 4500 w. Eng News—March 1, 1900. No. 32764.

Surveying.

A Method of Making a Farm Survey. G. B. Zahniser. Describes a method of land survey, and states its advantages. 1100 w. Eng News—March 29, 1900. No. 33196.

Surveys.

See Mining and Metallurgy, Mining.

MUNICIPAL.

Garbage.

Garbage Reduction Works at Pittsburg and Allegheny, Pa. Description of the plant and its operation. 3000 w. Eng News—March 29, 1900. No. 33195.

Highway Improvements.

The Modern Electric Railway and Permanent Street Improvement. C. E. McDowell. Gives instances of permanent improvement of the highways by trolley companies, and the benefits to suburban districts. 2300 w. Stone—Feb.-March, 1900. No. 32887 C.

Pavements.

Construction of Brick Pavements. George R. Grimes. Read at meeting of the Nat. Brick Mkrs. Assn. at Detroit, Considers the subject under seven heads. 3000 w. Brick—March 1, 1900. No. 32775.

Paving Brick and Brick Pavements. Daniel B. Luten. Read before the Indiana Engng. Soc. Illustrated report of the results of a study of different brick pavements and of a large number of tests of paving brick. 5000 w. Eng Rec—March 3, 1900. No. 32806.

Paving Brick and Brick Pavements. Arthur N. Talbot. A letter stating the relative advantages of different methods of testing paving brick. 1500 w. Eng Rec—March 24, 1900. No. 33130.

Standard Paving Brick Tests. A review of the work of the National Brick

Manufacturers' Assn., with the official list of tests adopted Feb. 9, 1900. Also editorial note on progress in brick paving. 3000 w. Eng Rec—March 17, 1900. No. 33044.

Sewage.

Bacterial Sewage Treatment, Owestry, England. A statement of the results attained with contact-bed methods of treatment. 1000 w. Eng Rec—March 10, 1900. No. 32962.

Recent Changes in Sewage Disposal, Worcester, Mass. Illustrated review of the history of the plant, explaining the peculiar difficulties in treating the 17,100,000 gals. of sewage from the city, and describing the sludge-pressing and filtration works recently added to the original chemical treatment works. 3500 w. Eng Rec—March 17, 1900. No. 33043.

Report on Sewage Sludge Deposits on the Experimental Coke Beds, London, England. Information from reports of Frank Clowes and A. C. Houston on the character of the deposits, the bacteria, and other matters of interest. 1100 w. Eng News—March 8, 1900. No. 32938.

The Clinton, Mass., Sewage Disposal System. Illustrated description of works noteworthy for the air pipes used to clean sewage basins and for concrete distributers for spreading sewage uniformly over filter beds. 500 w. Eng Rec—March 3, 1900. No. 32805.

The Operation of the Sewage Filter Beds at Brockton, Mass., in 1899. Information from the annual report of the city engineer. 1200 w. Eng News—March 29, 1900. No. 33194.

Sewerage.

The Drainage of the City of Mexico. A brief account of the nature of the work of two centuries to drain and sewer the city and valley of Mexico. 600 w. Eng Rec—March 24, 1900. No. 33120.

The Memorial of the Chicago Sanitary District. A statement of the reasons for making the drainage channel for Chicago's sewage a navigable waterway, and the necessity of improving the Illinois river to avoid disastrous floods which, the engineers have predicted from the inception of the work, would follow the discharge of 600,000 cu. ft. of water per minute into the river in its present state. 1500 w. Eng Rec—March 24, 1900. No. 33121.

Sewers.

A Large Storm-Water Sewer. Illustrated description of special intersections and crossings of main sewers in Boston. 600 w. Eng Rec—March 10, 1900. No. 32960.

Repairs to a Large St. Louis Sewer. Illustrates and describes the method of replacing the timber bottom of a sewer from 15 to 24 feet wide, by a concrete and brick invert. 500 w. Eng Rec—March 17, 1900. No. 33047.

Sewer Ventilation. A. Prescott Folwell. A description of the various methods employed, the results attained with each, and the present practice, as learned from recent investigations. 3900 w. Eng Rec—March 3, 1900. No. 32808.

Street Cleaning.

Street Cleaning in London. Describes methods used in St. Pancras vestry, which cost one-sixth of those in New York. 1300 w. Eng Rec—March 10, 1900. No. 32958.

Subways.

Subways for Street Pipes and Wires. Editorial on the need of such subways in New York, giving information concerning foreign cities, and suggesting the advisability of constructing them in connection with the rapid transit railway. Ill. 2500 w. Eng News—March 15, 1900. No. 33089.

MISCELLANY.

Address.

The Functions of the Engineer. William Henry Preece. Address delivered before the Glasgow Assn. of Students of the Inst. of Civ. Engs. 3000 w. Engr, Lond—Feb. 16, 1900. No. 32801 A.

Engineering Methods.

Working Methods of Engineering Contractors. James Brand. Facts from personal observations concerning earthwork excavations, tunnelling, rock cuttings, masonry, cranes, concrete, coffer dams and pumping, etc. 7700 w. Engr, Lond —March 9, 1900. No. 33033 A.

Plateways.

Plateways. A. Holt. Excerpt of a paper read before the Students' Engng. Soc., with editorial. An article advocating the practicability of the plateway system, and its power to revolutionize inland transportation. 6000 w. Automotor Jour—Feb., 1900. No. 32813 A.

Surveys.

Railroad Preliminary Survey by Stadia. John H. Lary. Description of work, with statement of the difficulties encountered. Discussion. 1800 w. Jour W Soc of Engs—Feb., 1900. No. 33339 D.

Recent Stadia Topographic Surveys: Notes Relating to Methods and Cost. William B. Landreth. The work reported was in connection with the proposed deep waterway on the Oswego-Mohawk-Hudson route, through New York State. Maps. 1500 w. Pro Am Soc of Civ Engs—March, 1900. No. 33305 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Laying a Telephone Cable Under Difficulties. A brief illustrated account of the laying of a cable to Martha's Vineyard. 1300 w. Elec Rev, N. Y.—March 14, 1900. No. 33012.

Cables.

Ocean Cables and International Commerce (Die Seekabel im Weltverkehr). A review of the present extent and importance of ocean cables, and a special description of the new German cable-laying steamer "Von Podbielski." 4000 w. 1 plate. Stahl und Eisen—Feb. 15, 1900. No. 33255 D.

Exchange.

Cincinnati Walnut Hills Telephone Exchange. H. E. Hall. Illustrated detailed description of this exchange, given as an example of improvements now under way in Cincinnati. 1800 w. Elec Wld & Engr—March 10, 1900. No. 32969.

Gutta Percha.

Gutta Percha (Die Guttapercha). E. Veyeraband. A general account of the production and properties of gutta-percha, with especial reference to its applications in electrical work. 4500 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33270 B.

The Supply of Gutta-Percha. Hawthorne Hill. On the sources of supply, and the demand, with related information. 1200 w. Elec Rev, N. Y.—March 7, 1900. No. 32949.

Space Telegraphy.

The Guarini Automatic Repeater (Repétiteurs Automatiques Guarini). Detailed description of an apparatus by which the range of communication can be extended from one station to another. 2000 w. L'Electricien—March 17, 1900. No. 33287 B.

Stray Currents.

See Street and Electric Tramways.

Telegraphs.

Improvements in Wheatstone Automatic Telegraph Apparatus. Illustrated description of the improved apparatus. 800 w. Elec Rev, Lond—March 2, 1900. No. 32983 A.

Underground.

Underground Work of the Illinois Telephone and Telegraph Company. Illustrated detailed description. 1700 w. W Elect'n—March 17, 1900. No. 33081.

DISTRIBUTION.

Alternating Currents.

A New Method of Tracing Alternating Current Curves. Fitzhugh Townsend. Describes a method recommended for its simplicity, accuracy and rapidity. 1800 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33065 D.

Principles of Alternating Current Distribution. Francis B. Crocker. Gives the principles of alternating currents, considering briefly the chief facts as a basis for study and calculations concerning alternating current-lines, transformers, etc. 6000 w. Sch of Mines Qr—Jan., 1900. No. 33016 D.

The Application of Complex Quantities to Alternating Current Circuits. Harold B. Smith. Explains methods of calculation. Diagrams. 2500 w. Jour of Worcester Poly Inst—March, 1900. No. 33023 C.

Aluminum.

Aluminum Electrical Conductors. Frank C. Perkins. Illustrated description of the works of the Pittsburg Reduction Company, with information relating to the use of this metal. 4000 w. W Elect'n—March 10, 1900. No. 33062.

Cables.

Cables for Electric Light and Power in Mine Shafts. Sydney F. Walker. Discusses the problem of protecting the cables from damage, and of keeping the water from destroying the insulating properties. 3500 w. Col Guard—March 2, 1900. No. 32976 A.

Cables for Electric Light and Power in Mine Shafts. G. W. Bousfield. Remarks on the opinions advanced by Sydney F. Walker in a recently published article. 1400 w. Col Guard—March 16, 1900. No. 33144 A.

Coils.

See Mechanical Engineering, Automobilism.

Storage Batteries.

The Regulation of Storage Battery Voltage. Roderick Macrae. Illustrates and describes some of the methods employed in operating storage batteries on distributing mains, discussing the different arrangements. 2400 w. Elec Wld & Engr—March 24, 1900. No. 33138.

Subways.

See Civil Engineering, Municipal.

Three-Wire.

Extension of Electrical Supply from

Three-Wire Stations. Alton D. Adams. Discusses three plans for extending the service area. 1800 w. Elec Wld & Engr—March 17, 1900. No. 33070.

Some Notes on Balancing and Boosting Sets. R. Wightman. Deals with the balance, its functions and design, noticing how these are affected by the addition of the boosters to the balancing set. 1800 w. Elec Rev, Lond—March 2, 1900. No. 32982 A.

Wiring.

Municipal Wiring a Failure in Boston. Alton D. Adams. Comment on information given in the report of the chief electrician of the wire department. 800 w. Elec Wld & Engr—March 10, 1900. No. 32972.

The Rearrangement of a Distribution System at Constant Resistance (Ueber Widerstandstreue Ungestaltung Elektrischer Leitungsnetze). J. Herzog and C. P. Feldmann. A graphical method of computing the conductors in changing or rearranging a distribution system. 3500 w. Elektrotech Zeitschr—March 1, 1900. No. 33274 B.

The Wiring of Houses for the Electric Light. Ed. C. de Segundo. Discusses proper methods of wiring, and the things *not* revealed by an insulation test. 1900 w. Elec Rev, Lond—Feb. 23, 1900. No. 32882 A.

ELECTRO-CHEMISTRY.

Alkalies.

The Electrolytic Production of Soda and Chlorine. James F. Hobart. The first paper is introductory. 1700 w. Am Elect'n—March, 1900. Serial. 1st part. No. 32861.

Copper Plating.

Electro-Deposition of Copper from Alkaline Solutions. Sherard Cowper-Coles. Illustrates and describes a plant recently erected at the works of the Société des Mines et Founderies de Zinc de la Vieille-Montague in Belgium, for electrodepositing copper upon metallic zinc sheets. 400 w. Elec Rev, Lond—Feb. 16, 1900. No. 32823 A.

Ozone.

The Industrial Production of Ozone. From *La Nature.* Illustrated description of the Otto Rotary Ozonizer. 900 w. Sci Am Sup—March 10, 1900. No. 32-930.

The Ozone Industry (L'Industrie de l'Ozone). M. H. Otto. An exhaustive discussion of the generation of ozone and its applications, especially in the sterilization of water. 10000 w. Mem Soc Ing Civ de France—Feb., 1900. No. 33291 G.

Progress.

Recent Progress in Electro-Chemistry. Herbert R. Kingman. Notes the theories and principles from which the commercial industries of this field have developed, and reviews the progress. 3500 w. W Elect'n—March 10, 1900. Serial. 1st part. No. 33076.

ELECTRO-PHYSICS.

Alternating Currents.

Fundamental Ideas of Alternating Currents. Dugald C. Jackson. Read at convention of the Northwestern Elec. Assn. A statement of the elementary electric and magnetic principles which relate to the flow of alternating currents. 1500 w. Elec Wld & Engr—March 17, 1900. Serial. 1st part. No. 33072.

Aluminum Electrodes.

The Luminescence of Aluminum Electrodes. W. S. Andrews. Illustrated description of a curious experiment with aluminum-carbon cells. 500 w. Elec Wld & Engr—March 24, 1900. No. 33-137.

Interrupter.

Comparison of Various Forms of Wehnelt Interrupter (Comparaison de Diverses Formes de l'Interrupteur de Wehnelt). A. Turpain. A communication to the French Academy, giving quantitative measurements of the results, using two forms of Wehnelt interrupter, and one of Foucault's design. 1200 w. Comptes Rendus—Feb. 12, 1900. No. 33-230 D.

Magnets.

Steels for Magnets. F. Osmond. From *Comptes Rendus.* An account of investigations carried on in the Sorbonne Laboratory of General Chemistry. 600 w. Metallographist—Jan., 1900. No. 32827 E.

Radiation.

Becquerel Rays. An illustrated account of these rays and their effect, and a comparison with the Röntgen rays. 1100 w. Elec Rev, Lond—March 9, 1900. No. 33-056 A.

Latest Developments with the X-Rays. John Trowbridge. Discusses the present state of knowledge, the art of using the X-rays, the methods of obtaining them, and information gained by their use. 4800 w. Ap Pop Sci M—April, 1900. No. 33177 C.

The Electric Charge Derived from the Divertible Rays of Radium (Sur la Charge Electrique des Rayons Déviables du Radium). M. and Mme. Curie. A communication to the French Academy discussing those rays emitted by radium which can be deviated by a magnetic field. 1500 w. Comptes Rendus—March 5, 1900. No. 33232 D.

X Rays and Discharge (Rayons X et Décharge). G. Sagnac. A communication to the French Academy discussing the relations of the X rays to the electric discharge, and giving a generalisation of the notion of cathodic rays. 1500 w. Comptes Rendus—Feb. 5, 1900. No. 33229 D.

X-Rays in Examination of Coal. An account of the investigations made by Prof. Henri Couriot, by radiometric analysis. 1100 w. Eng & Min Jour—March 17, 1900. No. 33075.

Spark.

A Wave-like Motion of an Electric Spark (Ueber eine Wellen förmige Bewegung Elektrischer Funken). E. Ruhmer. With reproductions of photographs of the peculiar forms and a discussion of the conditions and causes of the phenomena. 3000 w. Elektrotech Zeitschr—Feb. 22, 1900. No. 33273 B.

Volta Effect.

Contact Electricity. Editorial on the controversy, noting its antiquity and reviewing its history. 1400 w. Engng—Feb. 16, 1900. No. 32793 A.

Waves.

On Electric Touch and the Molecular Changes Produced in Matter by Electric Waves. Jagadis Chunder Bose. Abstract of a paper read before the Royal Soc. An account of investigations made in an attempt to reduce the action of contact-sensitiveness of metals to a systematic behavior. 3500 w. Elect'n, Lond—Feb. 23, 1900. Serial. 1st part. No. 32880 A.

GENERATING STATIONS.

Accumulator.

The Majert Accumulator (Accumulateur Majert). Describing especially the method of planing the sheet lead into ridges, furnishing a plate of greatly extended surface, well adapted for receiving the active material. 2500 w. Revue Technique—Feb. 10, 1900. No. 33214 D.

Alternating.

A 220-Volt Two-Wire Alternating Current Central Station. W. U. Zurfluh. Describes a plant installed at Rockford, Ohio. 1100 w. Am Elect'n—March, 1900. No. 32856.

Armatures.

Double-Wound Armatures. Alton D. Adams. Considers the class of double-wound armatures in which each winding is entirely independent of the other and has its own commutator. 2700 w. Am Elect'n—March, 1900. No. 32859.

Cells.

Cells for Accumulators (Ueber Akkumulatoren-Kasten). J. B. Hohn. Discussing especially the properties of hard rubber as used for the containing cells for accumulators. 800 w. Elektrochem Zeitschr—March 1, 1900. No. 33286 D.

Design.

The Design and Construction of Central Stations. C. Stanley Peach. Explains briefly the origin and development, and reviews the use, significance and design, studying the subject in detail. 6000 w. Builder—March 10, 1900. No. 33038 A.

Dynamos.

Fly-Wheel Continuous Current Generators (Gleichstrom-Schwungradmaschinen). F. Collischonn. Illustrating and describing vertical and horizontal engines in which the electric generator for continuous current is built-up upon the rim of the fly-wheel. Details of the windings and connections are given. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 1900. No. 33220 D.

New Steam Dynamos for Electric Traction at Hull. Illustrated description of two generating sets recently installed in the Hull Corporation Tramway Power Station. 1000 w. Elec Rev—March 16, 1900. No. 33162 A.

Some Mechanical Details of Dynamo Design. E. Kilburn Scott. Part first discusses the bedplate, field magnets, slide rails, winding cup, armature core, etc. Ill. 1300 w. Elec Rev, Lond—March 2, 1900. Serial. 1st part. No. 32984 A.

Electrical Energy.

Electrical Energy in Bulk. Editorial comment on the large number of engineering projects before Parliament, and the attitude of English municipalities. 2700 w. Engng—Feb. 16, 1900. No. 32792 A.

Electric Supply.

City-Road Electric Supply Station. Illustrated description of an English station. 3000 w. Engr, Lond—Feb. 23, 1900. No. 32876 A.

Ingleton Water-Power Electric Supply Works. Illustrated description of a British plant for village electric lighting. 1200 w. Elect'n, Lond—Feb. 16, 1900. No. 32818 A.

The Willesden Works of the Metropolitan Electric Supply Company. Illustrated detailed description of the works named and of the coaling arrangements. 2200 w. Elec Eng, Lond—March 9, 1900. Serial. 1st part. No. 33041 A.

Equipment.

Economic Equipment of Electric Stations. Alton D. Adams. Discusses the three general plans for the equipment of these generating stations. 3000 w. Elec Wld & Engr—March 3, 1900. No. 32002.

Exciter.

A New Method of Exciting Alternators (Ein Neues Erregungssystem für Wechselstrom Maschinen). A system of auxiliary brushes are arranged so as to deliver a current from the armature of the alternator for exciting the field. 3000 w. Elektrizität—March 3, 1900. No. 33285 B.

Legislation.

Swiss Legislation Concerning Safety in Electric Plants (Sicherheitsvorschriften über Elektrische Anlagen in der Schweiz). The full text of the Swiss law of July 7, 1899. Three articles, 10,000 w. Elektrotech Zeitschr—March 1, 8, 15, 1900. No. 33277 each B.

Lighting Stations.

The Electric Lighting Stations at St. Luke's, Clerkenwell, and at Wandsworth. Editorial describing these two plants and the three entirely different types of generating plant in the same station. 3000 w. Engng—Feb. 16, 1900. No. 32794 A.

Maximum-Demand.

The Maximum-Demand System of Charging for Electrical Energy. W. Perren Maycock. An explanation of the system, aiming to make it plain to the uninitiated. 2700 w. Elec Rev, Lond—March 2, 1900. No. 32985 A.

Municipal Plant.

Wallingford, Conn., Municipal Electric Lighting Plant. Thomas C. Perkins. Illustrated description of the interesting features of a small plant. 1500 w. Elec Wld & Engr—March 17, 1900. No. 33068.

Paralleling.

The Action of Parallel-Connected Alternators (Ueber das Verhalten Parallel Geschalteter Wechselstrommaschinen). Hans Görges. Giving a graphical method for showing the action, as well as differential equations for the alternations. 7500 w. Elektrotech Zeitschr—March 8, 1900. No. 33278 B.

Power Plants.

The Tariffville Plant of the Hartford Electric Light Company. Illustrated description of the construction of a concrete dam and power station for a 1,250 h.p. plant, with notes on the electrical features. 2300 w. Eng Rec—March 24, 1900. No. 33127.

Switchboard.

See Measurement.

Test.

The Guarantee Test of the Zürich Electric Plant (Abnahmeversuche der Dampf-Dynamo Anlage des Elektricitätswerkes der Stadt Zürich). H. Wagner. A detailed account of the test of two direct-connected steam dynamo sets of 1000 h.p. each. 4500 w. Elektrotech Zeitschr—Feb. 22, 1900. No. 33272 B.

Transformers.

A Transformer for Furnishing Large Currents. Illustrated description of a transformer of about 450 K.-W. capacity, built for the Acheson Graphite Co. 800 w. Eng News—March 8, 1900. No. 32943.

HEATING AND WELDING.

Annealing.

The Electric Process of Annealing Armor-Plate. An illustrated detailed description. 2500 w. Ir & Coal Trds Rev—March 16, 1900. No. 33154 A.

Thermostat.

An Electrical Thermostat. William Duane and Charles A. Lory. Illustrates and describes the construction of an electrical thermostat used in research work when it was necessary to keep the temperature of a bath constant for a considerable length of time. 1200 w. Am Jour of Sci—March, 1900. No. 32746 D.

Water Heating.

A Novel Application of Electric Heat. E. J. Hart. Brief account of a plan for warming the water of Lake Superior before admitting it to the city water-works system, thus remedying the trouble occasioned by "needle ice." 600 w. Elec Wld & Engr—March 17, 1900. No. 33071.

LIGHTING.

Air Pump.

The Berrenberg Pump for Exhausting Incandescent Lamps (Berrenberg'sche Luftpumpe für die Glühlampen fabrikation). The preliminary exhaustion is effected by a rotary pump and the final by a compound piston pump, using oil to fill all clearance spaces. 2500 w. Elektrotech Zeitschr—March 15, 1900. No. 33282 B.

Arc Lighting.

Cost of Arc Lighting. Discussion of paper by H. H. Wait. 6000 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33063 D.

Cable Breakdowns.

On Electric Lighting Cable Breakdowns. Gisbert Kappe, in *Electrotechnische Zeitschrift*. Reviews the causes of breakdowns, showing them to be often due to the improper connections. 3000 w. Elec Rev, Lond—March 9, 1900. Serial. 1st part. No. 33057 A.

Car Lighting.

See Railway Affairs, Motive Power.

Lamp Testing.

The Lamp-Testing Department of the New Orleans Edison Company. Lyman C. Reed. Describes the method of testing. Ill. 1300 w. Am Elect'n—March, 1900. No. 32857.

Lighting Stations.

See Generating Stations.

Nernst Lamp.

The Nernst Lamp. W. McA. Johnson. Gives a brief account of the first commercial application of the Nernst lamp, in Gottingen, Germany, the home of the inventor. 1000 w. Elec Wld & Engr—March 3, 1900. No. 32901.

Sub-Marine Lamp.

The Yale Sub-Marine Arc Lamp. Southard Hay. An illustrated account of this lamp and the satisfactory tests. It is expected that it will prove satisfactory for submarine photography. 1300 w. Yale Sci M—March, 1900. No. 32945 C.

MEASUREMENT.

Legislation.

The Law for the Measurement of Electricity (Das Gesetz betreffend die Elektrischen Maasseinheiten). F. Uppenborn. A discussion of recent legislation in Germany, regarding the measurement of electricity for sale. 4000 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33271 B.

Meters.

The Calibration of Meters for Multiple Circuits (Die Aichung von Mehrleiterzählern). W. Marek. A simple method of calibration by comparing a rotary meter with a pendulum meter. 1500 w. Elektrotech Zeitschr—March 1, 1900. No. 33275 B.

Standardization.

American Electrical Engineering Standardization. C. F. Guilbert. Comments on the report of the committee by a French engineer, also editorial. 6000 w. Elec Wld & Engr—March 3, 1900. No. 32903.

Standards.

The Facilities Afforded by the U. S. Office of Standard Weights and Measures for the Verification of Electrical Standards and Electrical Measuring Apparatus. Frank A. Wolff, Jr. Describes what has been accomplished, and gives a brief history of the units of reference. 4800 w. Elec Wld & Engr—March 10, 1900. No. 32971.

Switchboards.

Switchboard Instruments—Ammeters and Voltmeters. William Baxter, Jr. Diagrams illustrating the principles upon which nearly all the ammeters and voltmeters in actual use are constructed, are given and explained. 2000 w. Am Mach—March 8, 1900. No. 32909.

Testing.

A Differential Method of Testing Rail Bonding and Return Circuits for Electric Railways. Lincoln Nissley. Describes a method successfully employed by the writer in a recent test on one of the largest consolidated roads. 2800 w. St Ry Rev—March 15, 1900. No. 33004 C.

Engineering Tests on Direct Current Electrical Machinery with Preliminary Tests on the Properties of Conductors. George F. Sever. Gives description of the methods of dynamo and motor operation and testing, experimental work, etc. Ill. 7000 w. Sch of Mines Qr—Jan., 1900. No. 33017 D.

Voltmeter.

Reflecting Voltmeter of Large Range (Spiegel-Voltmeter mit Weitem Messbereich). W. Thiermann. A description of an instrument constructed for the Technical High School at Hanover, with a range from 750 volts down to 0.0007 volt. 3500 w. Elektrotech Zeitschr—March 15, 1900. No. 33281 B.

POWER APPLICATIONS.

Accumulators.

See Mechanical Engineering, Automobilism.

Constant Potential.

Methods of Controlling Direct Connected Motors. William Baxter, Jr. The discussion is confined to the constant potential type, and fully illustrated. 2200 w. Mach, N. Y.—March, 1900. No. 32853.

Controllers.

Controllers for Electric Motors (Die Steuerschalter für Elektrische Motoren). A full discussion of the principles of construction, with numerous diagrams, and photographs of working controllers. 3500 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33225 D.

Designs.

Designs for Combined Alternating and Direct-Current Machines. J. C. Brocksmith. Gives designs and working drawings for a type of machines useful in experimental and laboratory work. Describes the working in different ways. 3500 w. Am Elect'n—March, 1900. No. 32860.

Factory Driving.

Electricity at Lyman Cotton Mills. Describes an auxiliary two-phase installation used to drive four large mills when the hydraulic plant is inadequate. 600 w. Eng Rec—March 3, 1900. No. 32809.

The Electrical Transmission of Power (Transmission de Force par l'Electricité). An illustrated account of the use of "group driving," as installed in the "Louisiane" spinning and weaving mills at Ghent. 2500 w. Génie Civil—Feb. 17, 1900. No. 33202 D.

Friction.

The Friction of Unloaded Induction Motors (Ueber die Leerlaufreibung bei

Induktions Motoren). F. Blanc. A mathematical discussion of Braun's method, showing how possible errors in its application may be avoided. 2500 w. Elektrotech Zeitschr—Feb. 15, 1900. No. 33269 B.

Induction Motors.

Notes on Single-Phase Induction Motors and the Self-Starting Condenser Motor. Charles Proteus Steinmetz. Theoretical discussion and calculation. 6000 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 33064 D.

Mine Power.

Electricity in Anthracite Coal Mining. Ellis E. Brown. Considers the advantages and disadvantages of using electric power in transporting the coal from the working face to the breaker, and for the removal of water from workings. Ill. 3000 w. Jour of Worcester Poly Inst—March, 1900. No. 33022 C.

Motors.

Open v. Enclosed Motors for Stationary Work. Charles Leven. Discusses both types and favors the open motor. 1200 w. Elec Rev, Lond—March 9, 1900. No. 33058 A.

See Mechanical Engineering, Automobilism.

Organ Power.

Electric Motor Applied to Organ. Albert Siebert. Describes the manner of applying the power, and the advantages of the arrangement. 1000 w. Mod Mach —March, 1900. No. 32846.

Pump.

The Riedler Express Pump with Electric power (Reidler-Expresspumpen mit Elektrischem Antrieb). The application of the mechanically actuated valves of Prof. Riedler's design enables electrically driven pumps to be operated at high speed. 1000 w. Elektrizität—Feb. 17, 1900. No. 33284 B.

Spezia.

The Installation of Electric Power at the Arsenal at Spezia (L'Energia Elettrica pel Regio Arsenale Militare Marittimo della Spezia). A. Raddi. A general account of the proposed plan to supply the arsenal with electric power and light derived by the River Magra. 2000 w. L'Elettricita—Feb. 10, 1900. No. 33-283 B.

MISCELLANY.

Address.

Inaugural Address of Dr. Edward Hopkinson to the Manchester Section of the Institution of Electrical Engineers. Abstract. Discusses English electrical engineering. 3500 w. Elect'n, Lond—March 16, 1900. No. 33163 A.

Development.

Electrical Development in the United Kingdom. Discusses the effect of municipalization and legislation upon the development of electrical enterprise in England. 5500 w. Engr, Lond—March 2, 1900. No. 32979 A.

Exposition.

Electricity at the Pan-American Exposition. Frank C. Perkins. Brief illustrated account of the electrical attractions to be carried out. 1700 w. Elec Wld & Engr—March 24, 1900. No. 33-139.

Italy.

Electrical Progress in Italy During 1899. Enrico Bignami. A survey of the progress for the year. 1200 w. Elec Rev, N. Y.—March 7, 1900. No. 32950.

Medical Electricity.

On the Applications of Electricity in Medical and Surgical Practice. H. Lewis Jones. Read before the Inst. of Elec. Engs. Discusses the apparatus and methods, some of the difficulties met and problems to be solved. 8000 w. Elect'n, Lond—March 9, 1900. No. 33-055 A.

GAS ENGINEERING

Acetylene.

Acetylene and the Manufacture of Mineral Blacks. Georges F. Jaubert. From *La Revue des Produits Chimiques.* An account of experiments made for ascertaining a process suitable for the manufacture on a large scale. 2500 w. Sci Am Sup—March 17, 1900. No. 33010.

Acetylene Lamps for Miners' Use. K. Baumgartner, in *Allgemeine Bergmännische Zeitschrift.* Illustrates and describes a lamp made by the Velo Company, of Dresden-Löbtau. States the advantages and disadvantages. 1200 w. Col Guard—Feb. 23, 1900. No. 32873 A.

The Generation and Use of Acetylene. Concerning the appliances required for a complete acetylene installation, and the precautions to be observed in its erection. Ill. 2500 w. Builder—March 3, 1900. No. 32988 A.

The II. International Congress for the Carbide and Acetylene Industry (II. Internationaler Congress für Carbid und Acetylen-Industrie). H. Koechlin. A general review of the exposition at Budapest, with descriptions of the more important exhibits. 500 w. Oesterr Monatschr f d Oeffent Bandienst—March, 1900. No. 33250 G.

Address.

Inaugural Address before the Manchester District Institution of Gas Engineers. T. N. Ritson. Considers matters of interest to the gas industry. 8500 w. Jour Gas Lgt—Feb. 27, 1900. No. 32918 A.

Inaugural Address of D. Irving before the Southern District Association of Gas Engineers and Managers. Considers the demand for coal, spontaneous combustion, and matters of interest to the gas industry. 5000 w. Jour Gas Lgt—March 6, 1900. No. 33015 A.

Presidential Address Before the Midland Association of Gas Managers. J. Ferguson Bell. Reviews subjects of interest to the gas industry. 6700 w. Gas Wld—March 10, 1900. No. 33040 A.

Ammonia.

Ammonia: Its Saving and Concentration. George Osius. Read before the Michigan Gas Assn. A description of how to save it and how to prepare it for the market. 2000 w. Pro Age—March 1, 1900. No. 32786.

The Production of Liquor Ammoniæ from Gas Liquor. An outline of the recent work of Dr. Otto Pfeiffer, concerning improvements in the process of manufacture which he claims have resulted in a reduction in the cost of production. 1800 w. Jour Gas Lgt—March 13, 1900. No. 33101 A.

Carbide.

Calcium Carbide as a Means of Conversion of Work (Das Calcium Carbid als Mittel zur Arbeitsübertragung). E. Neuberg. An analysis of the thermochemical efficiency of the electric furnace in the production of carbide. 2500 w. Elektrotech Zeitschr—March 1, 1900. No. 33276 B.

The Manufacture of Calcium Carbide and its Relation to the Iron Industry (Die Calciumcarbidfabrication und deren Zusammenhang mit der Eisenindustrie). H. Liebetanz. A review of the carbide industry, showing that the use of furnace gas as a source of power may render its production advantageous in connection with iron works. Serial. Part I. 2500 w. Stahl und Eisen—March 1, 1900. No. 33256 D.

Charging.

The Mechanical Charging and Discharging of Gas Retorts (Chargement et Déchargement Méchaniques des Cornues à Gaz). An illustrated description of the Brackenburg hydraulic apparatus, as applied to the Lachomette retorts and furnaces. 1800 w. 1 plate. Génie Civil—March 10, 1900. No. 33211 D.

Coal Analysis.

A Laboratory Method for the Analysis of Coals for Gas Manufacture. J. G. A. Rhodin. Read before the Manchester section of the Soc. of Chem. Ind. Detailed description of apparatus used and manner of working. 3000 w. Gas Wld—Feb. 17, 1900. No. 32817 A.

Distribution.

Pumping Gas Five Miles at Twenty Pounds Pressure. F. H. Shelton. Read before the New England Assn. of Gas Engs. Describes a recently constructed high-pressure system which has worked successfully from the start. General discussion also. 8000 w. Am Gas Lgt Jour—March 5, 1900. No. 32848.

Fire-Brick.

Properties of Fire-Brick. Charles Feery. Considers each constituent which appears in an analysis of fire clay and the facts derived from the study. 2500 w. Gas Engs' Mag—March 10, 1900. No. 33161 A.

Fuel.

Some Notes on Oil and Tar Burning. Benjamin J. Allen. Read before the New England Assn. of Gas Engs. An account of experiments from the experience of the writer, with general discussion. Ill. 5000 w. Am Gas Lgt Jour—March 26, 1900. No. 33131.

Fuel Gas.

The Present Status of Fuel Gas. John R. Lynn. Read at meeting of the Ohio Gas Lgt. Assn. Discusses the possibility of manufacturing an economical gas for fuel purposes to take the place of natural gas, which is failing in quantity. 2800 w. Am Gas Lgt Jour—March 26, 1900. No. 33132.

Gas Compression.

The Rapid Delivery of Gaseous Bodies into Reservoirs under Pressure (Ueber Beziehungen der Pressungen Gasförmiger Körper au Stauflächen in Hohen Geschwindigkeit). Paul Fuchs. An examination of the action of a pressure-blower in delivering gas into a holder; with curves showing the effects of various pressures and velocities. 1200 w. Gesundheits-Ingenieur—Feb. 15, 1900. No. 33253 B.

Gasholders.

On Gasholders. Baurath Hacker. Abbreviated translation of a paper from the Journal of the Union of German Engineers. Discusses the uncertainty as to the distribution of wind pressure in the usual modes of construction, etc. Ill. 2300 w. Gas Wld—Feb. 24, 1900. No 32884 A.

Gas Making.

Reversible Reactions in Gas Making. Abstract translation of paper by Dr. Smits, in *Het Gas*. Explains the reactions. 1200 w. Gas Wld—Feb. 24, 1900. No. 32885 A.

Gas-Testing.

Gas Companies and Peripatetic Gas-Testing. Norton H. Humphreys. A discussion of the objections to the portable photometer system. 2500 w. Jour Gas Lgt—March 13, 1900. No. 33104 A.

Gas Wells.

Gas-Well Sections in the Upper Mohawk Valley and Central New York. Charles S. Prosser. Gives descriptions of the various wells, and of samples, with discussions of records. 2700 w. 5500 w. Am Geol—March, 1900. No. 32952 D.

Illumination.

Hygienic Lighting. F. Erismann. Translated from *Journal für Gasbeleuchtung*. Considers the quantity of light, the contamination of the air, heating, radiation, effect on the eye, etc. 5800 w. Pro Age—March 15, 1900. No. 33011.

Incandescent.

Sugg's Increased Pressure and Christiania Incandescent Burner Systems. Illustrates and describes apparatus for high-power incandescent gas lighting, and the operation. 1800 w. Jour Gas Lgt—March 13, 1900. No. 33103 A.

Mains.

The Distribution of Gas Under Pressure. A statement of a practical test of gas distribution under 20 pounds pressure. 1200 w. Eng Rec—March 10, 1900. No. 32964.

Under-Water Gas Main Construction. Discussion at meeting of the New England Assn. of Gas Engineers, opened by John A. Coffin. Ill. 6000 w. Am Gas Lgt Jour—March 19, 1900. No. 33073.

Meters.

Meter Testing. Paul Doty. Read before the Michigan Gas Assn. A description of meter testing and records and results of testing over 5000 meters. 1800 w. Pro Age—March 1, 1900. No. 32787.

Napthalene.

The Presence of Naphthalene in Coal Gas: A Novel Theory. R. W. Allen. A summary of the contents of a paper read at meeting of the London section of the Soc. of Chem. Ind. Gives experimental data presenting this question in a new aspect. Also editorial, correspondence, and discussion. 9000 w. Jour Gas Lgt—March 13, 1900. No. 33100 A.

Prices.

Differential versus Uniform Prices for Gas. Sedgwick Dean. Read before the Michigan Gas Assn. Reviews the claims of the systems. 2000 w. Pro Age—March 1, 1900. No. 32785.

Retorts.

Oven and Retort House Construction and Results. Discussion at meeting of the New England Assn. of Gas Engs. 7000 w. Am Gas Lgt Jour—March 12, 1900. No. 32951.

Retort-Settings in 1850 and 1900. A drawing of the Crosthwaite system of 1850, for the setting of three retorts, with editorial. 2200 w. Jour Gas Lgt—March 13, 1900. No. 33102 A.

Standards.

Some Fantastic Standards of Light. Résumé of paper by J. E. Petavel. An account of investigations made. 2000 w. Jour Gas Lgt—Feb. 20, 1900. No. 32820 A.

MARINE AND NAVAL ENGINEERING

Battleship.

Contract Trial of the United States Battleship "Kentucky." Harrie Webster. Illustrated description of the vessel and its equipment, with report of trial. 3800 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32990 H.

H. M. Torpedo-Boat Destroyer "Viper," with Parsons Turbines. Brief illustrated description. 500 w. Engng—Feb. 16, 1900. No. 32791 A.

The Evolution of Battle-Ship Construction (Note sur l'Evolution de la Construction des Navires de Combat). L. de Chasseloup-Laubat. A general examination of the work of various nations, with especial reference to the later vessels of the French navy. 4500 w. Mem Soc Ing Civ de France—Feb., 1900. No. 33292 G.

The New Brazilian Armorclad "Marshall Deodoro." C. Field. Brief description, with illustration. 500 w. Sci Am—March 24, 1900. No. 33095.

The New French Battleship "Suffern" and Her Predecessor. C. Field. Brief illustrated description. 500 w. Sci Am—March 24, 1900. No. 33094.

Cargo-Boats.

Twenty Years of Progress in Cargo-Boat Machinery. J. F. Walliker. Read before the Inst. of Marine Engs. at

Stratford. Discusses the subject of boilers principally, referring briefly to other machinery. 3000 w. Prac Engr—March 9, 1900. No. 33039 A.

Coal Handling.

Emptying Coal Boats. Jenner G. Marshall. Read before the Assn. of Mech. Engs., Birmingham, Eng. Describes methods of handling coal, taking it from the vessel and depositing it some distance. 2800 w. Col Guard—March 9, 1900. No. 33035 A.

Compass.

The Evoy Compass. Illustrates and describes a compass so constructed as to enable it to be hoisted aloft to remove it from the effects of magnetic material, and enable its reading to be correctly taken on the bridge or deck. 500 w. Engr, Lond—Feb. 16, 1900. No. 32800 A.

Cruiser.

Our Latest Protected Cruiser, the "Albany." Illustrated description of an English-built cruiser purchased by the U. S. at the opening of the Spanish War, and but recently completed. 1400 w. Sci Am—March 10, 1900. No. 32926.

Dock Equipment.

Dock Equipment for the Rapid Handling of Coal and Ore on the Great American Lakes. Arthur C. Johnston. Illustrates and describes the special types of machinery built for the purpose of insuring quick dispatch in loading and unloading the ore and coal. 4500 w. Jour Assn of Engng Socs—Jan., 1900. No. 32833 C.

Disinfecting.

Disinfecting Steamer "Sanator" for the U. S. Marine Hospital Service. C. M. Green. Illustrated detailed description of a floating disinfecting plant. 4800 w. Marine Engng—March, 1900. No. 32-916 C.

Forced Draft.

Limits to the Use of Forced Draft for Marine Boilers. Walter M. McFarland. A discussion of naval study and experiment in economy of space and evaporation, showing the advantages and limitations of forced draft in marine service. 4000 w. Engineering Magazine—April, 1900. No. 33298 B.

Germany.

The New Naval Bill (Aus der Novelle zum Flottengesetz). A tabulated description of the vessels included in the bill, with a schedule of the construction work allotted to each year. 2500 w. Glaser's Annalen—Feb. 15, 1900. No. 33-252 D.

Ice Breakers.

Ice Breaking Vessels (Les Navires Brise-Glace). M. Hachebet. A description of the Russian ice-breaking vessel "Ermack," with photographs of the boat in service, breaking a channel through heavy ice. 2500 w. Génie Civil—Feb. 24, 1900. No. 33204 D.

Lightship.

Steam Electric Lightship for Cape Hatteras. Illustrated description. 1200 w. Sci Am—March 17, 1900. No. 33008.

Merchant Marine.

The American Merchant Marine. Winthrop L. Marvin. Reviews the history of American ship owning, discussing the causes, and steamship subsidies and the Frye bill. 6000 w. Rev of Revs—March, 1900. No. 33059 C.

Navigation.

Notable Incidents in Early Ocean Steam Navigation. Part first gives a brief account of the first iron steamship, the "Great Britain," how she came to be built, and the disaster that overtook her. Ill. 5000 w. Engr, Lond—March 16, 1900. Serial. 1st part. No. 33148 A.

Navy Yard.

New York Navy Yard, Brooklyn. Gives briefly the history of this yard, describing the buildings and various departments, and the proposed improvements. Ill. 2700 w. Sci Am—March 3, 1900. No. 32756.

Pacific Lines.

Steamship Lines of the Pacific Coast—Present Facilities and Probable Future Growth. D. S. Kimball. An account of the principal companies and illustrations of vessels. 3200 w. Marine Engng—March, 1900. No. 32913 C.

Propulsion.

On the Mechanical Theory of Steamship Propulsion. Robert Mansel. An account of investigations, giving results and discussing the subject generally. 3000 w. Engr, Lond—March 9, 1900. No. 33028 A.

Review.

A Retrospect and the Outlook on Marine Engineering. Waldon Fawcett. A review of the development, presenting many facts of interest. 3000 w. Ir Age—March 29, 1900. No. 33180.

River Boats.

Boats on the Volga (Schiffe auf der Wolga). R. Wels. Illustrating and describing the shallow draft steamers for Russian river service, especially the tank vessels for the transport of petroleum and naphtha. 3000 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33-224 D.

Russia.

Merchant Marine of Russia. Information relating to the number of vessels and their location on different seas, size, appointment, etc. 1000 w. U. S. Cons Repts, No. 682—March 20, 1900. No. 33054 D.

Russian Mercantile Marine. Editorial review of points in the last report of the Acting-Consul of Odessa. 1500 w. Engng—March 9, 1900. No. 33027 A.

Screws.

The Theory of Propulsive Screws (Théorie des Helices Propulsives). M. Ratedie. A communication to the French Academy, reviewing the theory of Drzewiecki, in which the surface of each blade of a propeller is decomposed into its elements in order to enable its action to be investigated. 1200 w. Comptes Rendus—Feb. 19, 1900. No. 33231 D.

Sheathing.

Notes on Sheathing U. S. Naval Academy Practice Ship "Chesapeake." Lloyd Bankson. Read at New York meeting of the Soc. of Nav. Archts. and Marine Engs. Illustrates and describes the process of sheathing. 2000 w. Marine Engng—March, 1900. No. 32914 C.

Sheathing of Ships. Concerning the discussion of the naval board of construction as to whether the new vessels of the U. S. navy shall or shall not be sheathed. 3000 w. Marine Rev—March 22, 1900. No. 33136.

Shipbuilding.

Shipbuilding in England and Germany. Translation of a German newspaper clipping, giving reports for 1898 and 1899. 700 w. U. S. Cons Repts, No. 671—March 7, 1900. No. 32871 D.

Steam Turbine.

See Mechanical Engineering, Steam Engineering.

Steamer.

A Magnificent Inland Steamer. Description of the "Augusta," just completed for service on Chesapeake Bay. 1800 w. Naut Gaz—March 1, 1900. No. 32773.

Steering.

An Improved Form of Equilibrium Steering Gear (Nouveau Type de Gouvernail Equilibré). A description of the Joessel steering gear, in which a geared tumbling bob is used to counteract the lateral pressure upon the rudder. 1200 w. Génie Civil—Feb. 24, 1900. No. 33207 D.

Subsidies.

The Policy of Steamship Subsidies. Arthur T. Hadley. An argument against steamship subsidies as a means of relieving congested public treasuries, reprinted from a work printed in 1888. 4000 w. Rev of Revs—March, 1900. No. 33060 C.

Torpedo-Boat.

Progressive Trials of the Italian Torpedo Boat "Condor." From *Revista Marittima.* Brief description of vessel, with report of trials. 1500 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32992 H.

Torpedo Practice.

Torpedo Practice at Newport, R. I. Instantaneous photograph of discharge, with description. 700 w. Sci Am—March 10, 1900. No. 32925.

Tugs.

New Steel Screw Transfer Tugs for the N. Y., N. H. & H. Railroad Co. Illustrated detailed description of interesting examples of this type. 2500 w. Marine Engng—March, 1900. No. 32915 C.

Warships.

The Classification of Warships. Fred. T. Jane. Comparative tables of the warships of England, France, Germany, and Russia, with explanatory notes of interest. 3800 w. Engr, Lond—March 9, 1900. No. 33030 A.

Water-Tube.

See Mechanical Engineering, Steam Engineering.

Yacht.

Palatial Steam Yacht. Description of the "Dreamer," just completed for T. W. Lawson, by Lewis Nixon. 1800 w. Naut Gaz—March 8, 1900. No. 32944.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Accumulators. Félicien Michotte. An illustrated explanation of the apparatus and its working. 2800 w. Auto Mag—March, 1900. No. 32865 C.

Carburettor.

The Longuemare Petroleum (Heavy Oil) Carburettor. Illustrated description of the improved apparatus. 500 w. Automotor Jour—March, 1900. No. 33155 A.

City Vehicles.

The Street Car of the Future. Waldon Fawcett. Considers the automobile in its relation to electric lines in the city and suburbs, in parks and boulevards, etc. Ill. 2000 w. Auto Mag—March, 1900. No. 32863 C.

Coils.

Induction Coils. H. E. Wimperis. An illustrated account of the construction and working. 900 w. Automotor Jour—March, 1900. Serial. 1st part. No. 33156 A.

Combination Carriage.

The Pieper Combination Carriage. Illustrated description of a vehicle fitted with both a gasoline motor and a storage battery electric motor. 500 w. Horseless Age—March 7, 1900. No. 32947.

Compressed Air.

A Compressed Air Automobile (Une Automobile à Air Comprimé). Daniel Bellet. A description of the Molas, Lamielle and Tessier vehicle, with details of the compressed air motor and differential gearing. 3000 w. Revue Technique—Feb. 10, 1900. No. 33212 D.

Electric Cab.

Working Drawings of an Electric Cab. Gives drawings illustrating the design of the side elevation and mechanical features. 2200 w. Sci Am Sup—March 10, 1900. No. 32929.

Electromobile.

The Draulette Electromobile. Illustrated description of a cab differing in general appearance and driving mechanism from other electric vehicles. 1000 w. Auto Mag—March, 1900. No. 32864 C.

Motors.

Motors for Electric Automobiles. P. M. Heldt. Describes various innovations in this line, and discusses the problems. Ill. 2000 w. Elec Wld & Engr—March 10, 1900. No. 32970.

Motor Trials.

French Motor Trials. An account of the series of trials carried out in Paris to determine the actual power of motors as fitted to automobile vehicles, with tabulated results. 1400 w. Automotor Jour—Feb., 1900. No. 32815 A.

Motor Vehicles.

Automobiles Up-to-Date. From *The Blacksmith and Wheelwright.* Discusses the degree of success attained by the motor vehicle of to-day, claiming there is not yet a perfectly successful or reliable automobile. 4000 w. Am Mfr & Ir Wld—March 22, 1900. No. 33113.

The Hon. Evelyn Ellis's Motor Vehicles. An interesting series of photographs of various vehicles, with brief descriptions. 400 w. Automotor Jour—March, 1900. No. 33157 A.

Petroleum.

The "Mees" Petromobile. An illustrated account of the system introduced by Gustav Mees, noting the novel and interesting features. 3000 w. Automotor Jour—March, 1900. No. 33158 A.

Racing.

Automobile Club Racing. A copy of the rules and regulations of the Automobile Club of Great Britain and Ireland. 5000 w. Automotor Jour—March, 1900. No. 33160 A.

Rear Driving.

Effect of Rear Driving to Roughen the Road for the Automobile. M. C. Krarup. Discusses the effects of rear driving and its drawbacks. 1800 w. Am Mach—March 8, 1900. No. 32910.

Report.

Report on Motor Vehicles for Municipal Purposes. T. W. E. Higgens. Report presented to Chelsea Vestry on the various vans inspected. 1600 w. Automotor Jour—March, 1900. No. 33159 A.

Steam Wagons.

The Ideal Automobile. William Howard Paine. Considers the advantages and disadvantages of several types of carriages now in use, favoring the steam vehicles. 1700 w. Mod Mach—March, 1900. No. 32844.

Thornycroft Works.

The Thornycroft Steam Wagon Company. An illustrated account of the works and some of the vehicles. 2500 w. Automotor Jour—Feb., 1900. No. 32814 A.

Tires.

Automobile Tires. H. Falconnet. Illustrated description of such systems as have proven practicable, with the advantages of each. 2200 w. Auto Mag—March, 1900. No. 32866 C.

Traction Engines.

War Automobiles. From *La Nature.* Illustrations and particulars concerning the advantages of traction engines. 700 w. Sci Am Sup—March 10, 1900. No. 32928.

Trolley.

Automobile Trolley for Use on Highways (Trolley Automoteur pour les Transports Automobiles sur Routes). Ch. Dantin. An illustrated description of the Lombard-Gerin system, using an electrically propelled trolley and overhead wires for motor vehicles. 2500 w. Génie Civil—Feb. 10, 1900. No. 33200 D.

Distribution by Wire for Electric Traction on Roads (Application de la Distribution par Fils à la Traction Electrique sur Routes). N. de Tedesco. The Lombard-Gerin system enables electric vehicles to obtain current from overhead wires, by means of an automatic trolley. 2000 w. Revue Technique—Feb. 25, 1900. No. 33215 D.

Self-Moving Road Vehicles with Automobile Double Trolleys. E. Hospitalier, in *L'Industrie Electrique.* Illustrated description of an automobile trolley, designed by M. Lombard-Gerin. 800 w. Elec Rev, N. Y.—March 7, 1900. No. 32948.

Weight.

The Weight of Motor Wagons. Editorial discussion of the British Light Locomotives Act of 1896. 3000 w. Engng —March 16, 1900. No. 33145 A.

Wheels.

Dished Wheels. H. E. Wimperis. Considers their advantages and disadvantages when applied to motor cars. 1200 w. Automotor Jour—Feb., 1900. No. 32816 A.

HYDRAULICS.

Pumping Engines.

The Old and New Pumping Engines of Dry Dock No. 1, Brooklyn Navy Yard. Illustrated description, showing the advance made in this class of machinery. 1500 w. Sci Am—March 24, 1900. No. 33096.

Water Lifts.

Installation of Water Lifts. Illustrated description of four systems of installing water lifts. 1000 w. Dom Engng—March 15, 1900. No. 33067 C.

Water Power.

The New Water Power of the Hartford Electric Light Company. W. L. Robb. Illustrated detailed description. 1500 w. Am Elect'n—March, 1900. No. 32855.

MACHINE WORKS AND FOUNDRIES.

Analysis.

Analysis in the Foundry. Stuart B. Marshall. Discusses various elements and their effects, and considers chemical analysis the only true selling guide. 1800 w. Ir Trd Rev—March 15, 1900. No. 33013.

Armory.

The United States Armory at Springfield, Mass. D. E. MacCarthy and F. J. M. Illustrated description of the oldest and most famous of the U. S. workshops and the manufacture of the army magazine rifle, known as the Krag-Jorgensen. 2500 w. Am Mach—March 22, 1900. Serial. 1st part. No. 33105.

Bearings.

On Antimonial Alloys for Axle Bearings. H. Behrens and H. Baucke. An account of chemical and microscopic examination of several cushions of Babbit metal with a view of ascertaining the causes leading to hot boxes. 3000 w. Metallographist—Jan., 1900. No. 32-826 E

White Metal or Gunmetal for Bearings. W. H. Booth. Discusses the conditions that have caused the more extensive use of white metal in America than in England, and the importance of the best lubrication obtainable. 800 w. Am Mach—March 1, 1900. No. 32748.

Blue-Printing.

A Novel and Convenient Blue-printing Gallery. Illustrates and describes the arrangements at the works of the Brown Hoisting and Conveying Machine Co., of Cleveland, Ohio. 600 w. Am Mach—March 29, 1900. No. 33185.

Castings.

A Casting With a Troublesome Core. R. H. Palmer. Illustrates and describes the casting of a drying machine column. 900 w. Am Mach—March 15, 1900. No. 32999.

Cast Iron.

Annealing Malleable Cast Iron. George C. Davis. Prepared for the Foundrymen's Assn. Also discussion by Dr. Richard Moldenke. On the changes resulting from annealing, with experiments. 3000 w. Ir Trd Rev—March 8, 1900. No. 32911.

Compasses.

Compass for Drawing Arcs of Large Radius. Ulrich Peters. Illustrates and describes a system of link connections. 800 w. Am Mach—March 22, 1900. No. 33106.

Cores.

Judgment in the Use of Cores. R. H. Palmer. Suggestions for the making and setting of cores. 1300 w. Am Mach—March 8, 1900. No. 32907.

Design.

The Genesis of Machine Design, with Applications. W. H. Sargent. An illustrated article presenting some suggestions showing the influence of natural forms, and discussing shop designing. 2300 w. Mach, N. Y.—March, 1900. No. 32852.

Draughting.

Draughting Department, Union Iron Works. Illustrated description of the special drafting building, furniture and methods of management in a San Francisco ship and machinery building establishment, where the designing is particularly difficult because of the distance of the plant from the sources of supply in the Eastern States. 3000 w. Eng Rec—March 10, 1900. No. 32963.

The New Drafting Room of the Brown & Sharpe Manufacturing Company. L. D. Burlingame. Illustrated detailed description of a finely equipped room. 2000 w. Am Mach—March 8, 1900. No. 32908.

Drill Grinder.

A Constantly Adjusted Twist Drill Grinder. Illustrated detailed description.

700 w. Am Mach—March 1, 1900. No. 32749.

Engine Frame.

Two Ways of Machining an Engine Frame. B. W. T. Illustrates and describes the methods. 1800 w. Am Mach—March 29, 1900. No. 33184.

Foundry Irons.

Foundry Irons. Edward Kirk. Short descriptions of the various irons, their characteristics and uses. 4500 w. Foundry—March, 1900. No. 32832.

Gear Teeth.

Cutting Wheels With Prime Numbers of Teeth. Richard Inwards, in the *English Mechanic and World of Science*. Illustrates and describes the method. 900 w. Prac Engr—Feb. 23, 1900. No. 32886 A.

New Forms for Gear Teeth (Neuere Zahnformen). G. Lindner. Especially discussing the effect of shortening the points of the teeth to avoid undercutting of low numbered pinions. The special forms of rack and pinion teeth for rack railways are also discussed. 5000 w. Zeitschr d Ver Deutscher Ing—March 10, 1900. No. 33228 D.

The Geometrical Generation of Irregular Surfaces in Machine Construction. Henry Roland. Giving the history and practice of the modern method of producing theoretically correct tooth forms by the movement of the surfaces. 3000 w. Engineering Magazine—April, 1900. No. 33299 B.

Interchangeability.

Interchangeability of Units in Machinery. W. D. Forbes. On the value of the interchangeable unit, and the advantages. 1200 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32994 H.

Iron Works.

The Works and Operations of Palmer's Shipbuilding and Iron Company. Illustrates and describes principally the foundries and blast-furnaces, and methods of manufacture of pig iron and steel. 2400 w. Ir & Coal Trds Rev—Feb. 16, 1900. No. 32802 A.

Living Force.

A Simple Method of Measuring Living Force (Ein Einfaches Verfahren zur Messung Lebendiger Kräfte). H. Heim. The force of the blow of a hammer or other falling mass is permitted to crush a cylinder of lead, the magnitude of the force being computed by the extent of the deformation of the lead. 1800 w. Zeitschr d Ver Deutscher Ing—March 3, 1900. No. 33226 D.

Lubricants.

Air as a Lubricant. Herman S. Heichert. From the *Rose Technic*. Describes experiments being made at the Worcester Polytechnic Inst., with a machine designed by Albert Kingsbury. Ill. 1000 w. Eng News—March 8, 1900. No. 32939.

Experiments With an Air-Lubricated Journal. Albert Kingsbury. Describes the apparatus used and gives experimental results. Ill. 5000 w. Jour of Worcester Poly Inst—March, 1900. No. 33021 C.

Machinery.

A Comparison Between Hand and Machine Work (Comparaison du Travail à la Main et du Travail à la Machine). M. E. Levasseur. An exhaustive examination of the influence of machinery upon industry, with numerous historical and official references. Serial, Part I. 12000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33240 G.

Milling Machines.

One of the Earliest Milling Machines. E. G. Parkhurst. Illustrates and describes a primitive hand milling machine made in 1818. 800 w. Am Mach—March 8, 1900. No. 32906.

Molding.

Molding a Propeller Wheel in Green Sand. R. H. Palmer. Shows a way of molding a propeller wheel of four blades from a pattern of one blade. Ill. 900 w. Am Mach—March 1, 1900. No. 32747.

Patterns.

Pattern Making—Using Loose Pieces Instead of a Core. John M. Richardson. Illustrated description, showing how loose pieces can be used to advantage. 600 w. Am Mach—March 22, 1900. No. 33108.

Pipe Threads.

The Unification of Pipe Threads (Unification des Filetages sur Tubes). A communication from the Royal Institute of Engineers of the Netherlands urging united action to secure uniformity, and providing blank forms for replies. 1000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33243 G.

Pneumatic Tools.

Portable Pneumatic Tools. Ewart C. Amos. Read before the Inst. of Mech. Engs. Describes the mechanism for utilizing compressed air, and the various tools to which it is applied. Ill. 3700 w. Engng—March 2, 1900. Serial. 1st part. No. 32975 A.

Power-Hammer.

The Longworth Power-Hammer. Ernest Samuelson. Read before the Inst. of Mech. Engs. Drawings illustrating improvements made, with description. 2200 w. Engng—March 2, 1900. No. 32974 A.

Rearrangement.

Locating Tools in a Reconstructed Shop. A description of the location of tools and the appliances for handling and machining the various parts of engines. 1100 w. Am Mach—March 1, 1900. No. 32750.

Seamless Tubes.

A Machine for Drawing Seamless Steel Tubes with Longitudinal Ribs. Illustrated description of the methods of manufacture, and statement of advantages claimed. 1200 w. Eng News—March 1, 1900. No. 32765.

Shrinkage.

Shrinkage and Disintegration of Metals. W. Roxburgh. Remarks on the relation of the two terms used, with the opinion that shrinkage must be recognized as the cause of disintegration. 1400 w. Foundry—March, 1900. No. 32831.

Tool Holder.

A Gang Tool Holder for the Planer. Illustrates a design for such a tool, and remarks on its use. 400 w. Am Mach—March 22, 1900. No. 33107.

Tools.

American Machine Tools. Information concerning shop practice, with illustrated detailed descriptions of many of the tools. 2700 w. Engr, Lond—Feb. 16, 1900. Serial. 1st part. No. 32798 A.

Liquid Operated Machine Tools. F. Thornely. Illustrated description of a hydraulic vertical planer, and of a proposed water motor system. 400 w. Am Mach—March 15, 1900. No. 33000.

Tubes.

The Manufacture of Seamless Tubing (Verfahren zur Herstellung von Nahtlosen Hohlkörpern). H. Zobler. A description of the Erhardt process, by which a steel mandrel is pressed through the solid blank, which is afterwards drawn. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 10, 1900. No. 33218 D.

MATERIALS OF CONSTRUCTION.

Buckling.

Investigations Into the Buckling of Piston Rods (Untersuchung der Knickfestigkeit von Kolbenstangen). G. Huguenin. A mathematical investigation of the forces and their action upon a piston rod in a steam engine, with diagrams deduced from the equations. A practical example is given. 1800 w. Schweizerische Bauzeitung—March 3, 1900. No. 33247 B.

Rubber.

A Study of Rubber Production in the Soudan (Etude sur le Caoutchouc au Soudan). M. Hamet. An abstract of the report of the French scientific commission, showing the adaptability of the Landolphia Hendolotti for cultivation in the Soudan. 3000 w. Bull de la Soc d'Encour—Feb. 28, 1900. No. 33242 G.

Tanks.

Calculations for Sheet-Iron Tanks (Calculs de Réservoirs en Tôle). Maurice Koechlin. A mathematical discussion of the computation of the forms of tanks, so that the stresses in the bottom shall neutralize each other. The method of Professor Intze is employed. 2500 w. Génie Civil—March 3, 1900. No. 33209 D.

POWER AND TRANSMISSION.

Air-Compressors.

Hints Concerning Air-Compressors. H. H. Kelley. Illustrates and describes the construction and operation. 2200 w. Engr, U. S. A.—March 1, 1900. No. 32905.

Air Propellers.

The Lifting Power of Air Propellers. William George Walker. Illustrated description of experiments on the thrust or lifting power of air propellers 30 feet in diameter. 2500 w. Engng—Feb. 16, 1900. No. 32796 A.

Belts.

Length of Belts. A demonstration of the ways of solving the problem. 1200 w. Prac Engr—Feb. 16, 1900. No. 32803 A.

Hospital Plant.

Light, Heat and Power at the Kankakee Hospital. Illustrated description of a new plant recently installed. 2000 w. W Elect'n—March 3, 1900. No. 32854.

Linkages.

Straight Line Motions. From a paper by John B. Peddle in *The Rose Technic.* Illustrates and describes various classes. 1800 w. Am Mach—March 15, 1900. No. 32998.

Pneumatic Despatch.

Pneumatic Despatch. C. A. Carus-Wilson. Gives an illustrated description of various means tried in London for conveying the mails, and discusses the pneumatic tube circuits now in use in various places. Discussion. 6600 w. Jour Soc of Arts—March 2, 1900. No. 32973 A.

Ropes.

Hoisting Ropes. Robert Peele. Considers the various kinds in use and the properties which influence their strength and life. 4200 w. Mines & Min—March, 1900. No. 32780 C.

Variable-Speed.

A Variable-Speed Power Transmission Apparatus. Illustrated description of the Reeves device. 500 w. Eng News—March 1, 1900. No. 32767.

SPECIAL MOTORS.

Gas Engines.

Large Gas Engines (Grosse Gasmaschinen). E. Meyer. A discussion of the development of the large gas engine, with especial reference to the use of producer and furnace gases, with illustrations of recent designs. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 10, 1900. No. 33227 D.

Gasoline.

The Gasoline Engine. H. S. Pell. Read before Toronto No. 1 Canadian Assn. of Stationary Engs. Discusses the main features of the gasoline engine, the characteristics of the fuel, etc. 3800 w. Can Elec News—March, 1900. No. 33-019.

Gas Power.

Gas Engines and Electricity Supply Stations. Alton D. Adams. A careful presentation of the advantages possessed by gas as a means of transmission of energy, in connection with gas engines at the electric generating stations. 3000 w. Engineering Magazine—April, 1900. No. 33295 B.

Motor Trials.

See Automobilism.

Petroleum.

See Automobilism.

Turbine.

The Utilization of Heat in the Hot-Air Turbine (Wärmeausnutzung der Heizluftturbinen). V. Lorenc. A mathematical discussion of motors of the class in which the heated gases of combustion are projected against an impact turbine, showing that no higher thermal efficiency can be expected than has already been attained with the steam engine. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 24, 1900. No. 33223 D.

Water Motors.

The Construction of Small Water Motors. P. Pitman. Explanation of the principles underlying the action of water-motors, and the application of those principles to their design and construction on a small scale. Ill. 2000 w. Elec, Lond—March 9, 1900. Serial. 1st part. No. 33097 A.

STEAM ENGINEERING.

Boiler Accident.

A Remarkable Boiler Accident. W. F. Durand. Describes an accident to a boiler on a tug-boat in N. Y. harbor, which caused the complete melting of a mass of wrought iron boiler tubes, with no explosion. Also suggestions of a possible solution. Ill. 1400 w. Sib Jour of Engng—March, 1900. No. 33-175 C.

Boiler Feeders.

Selecting a Boiler Feeder. W. H. Wakeman. Presents the advantages and disadvantages of pumps and injectors. 2400 w. Mod Mach—March, 1900. No. 32845.

Chimneys.

The Monumental Chimneys of the Champ-de-Mars (Cheminées Monumentales du Champ-de-Mars). E. Cayla and P. Lerolle. Giving illustrations of the two great chimneys of the Paris Exposition, and the full detailed calculations of the draft, with comparisons of other large chimneys. 4000 w. 1 plate. Génie Civil—Feb. 10, 1900. No. 33201 D.

Distilling Plant.

Report of a Six-Day Trial of the "Lillie" Multiple-Effect Distilling Plant at Dry Tortugas, January 13 to 20, 1900. R. K. Crank. Describes the methods and plant, giving results of the test, and other information of interest. Ill. 3700 w. Jour Am Soc of Naval Engs—Feb., 1900. No. 32993 H.

Engines.

Relative Efficiency and Desirability of Various Types of Engines on Central Station Loads. A. W. Richter. Abstract of a paper read before the Northwestern Electrical Assn. Discusses various types, and the points to be considered in connection with the local conditions in choosing an economical outfit. 3000 w. St Ry Rev—March 15, 1900. No. 33005 C.

The Politics of the Steam Engine. Fred W. Lehmann. Discusses the influence the steam engine has had in the development of national life in the United States. 6300 w. Pro St. Louis Ry Club—March 9, 1900. No. 33181.

Feed Water.

Feed Water Purification. Methods for separating the salts from water as received from rivers and wells. Ill. 1800 w. Am Elect'n—March, 1900. No. 32-862.

The Work of Railroad Men on the Problem of Pure Water for Steam Boilers. C. Herschel Koyl. Part first reviews the valuable statistics gathered by the Master Mechs.' Assn. in their investigations of boiler water. 1700 w. R R Gaz—March 23, 1900. No. 33110.

Firing.

Firing. H. H. Kelley. Suggestions for changing the methods of firing to suit the conditions. Ill. 2500 w. Engr, U. S. A.—March 15, 1900. No. 33080.

Steam Turbines.

Steam Turbines and High-Speed Vessels. Charles A. Parsons. Abstract of the Presidential Address to the Inst. of Jun. Engs. Considers the applications of the steam turbines and the advantages. Ill. 3000 w. Ap Pop Sci M—April, 1900. No. 33178 C.

Motive Power. Steam Turbines. High Speed Navigation. C. A. Parsons. A discourse delivered at the Royal Inst. An account of the progress of the steam turbine and its applications and advantages. 6000 w. Nature—March 1, 1900. No. 32946 A.

The Westinghouse-Parsons Steam Turbine. Describes and illustrates the turbines recently installed in the power plant of the Westinghouse Air Brake Co., at Wilmerding, Pa. 2300 w. Am Engr & R R Jour—March, 1900. No. 32759 C.

Thermodynamics.

An Experimental Investigation of the Thermodynamical Properties of Superheated Steam. John H. Grindley. Investigates the law of flow of saturated steam through small orifices, and the cooling by free expansion, and other properties. 2500 w. Engr, Lond—March 16, 1900. No. 33153 A.

Valve Gear.

See Railway Affairs, Motive Power.

Waste Heat.

Utilization of Waste Heat. Editorial discussion of the steam engine and steam boiler in this connection. 2000 w. Engr, Lond—Feb. 23, 1900. No. 32877 A.

Water-Tube.

Practical Data Relating to the Building of Bent-Tube Boilers. John Platt. A general description of the plan adopted in laying out and building one of these boilers. Ill. 3500 w. Jour Am Soc of Nav Engs—Feb., 1900. No. 32991 H.

Water-Tube Boiler (Générateur à Vapeur Aquitubulaire). A description of the Turgan boiler; inclined Field tubes are used, connected to a central steam and water drum overhead. 1500 w. Revue Technique—Feb. 25, 1900. No. 33217 D.

MISCELLANY.

Aeronautics.

The Navigation of the Air (La Navigation Aerienne). R. Soreau. A discussion of the influence of the wind near the surface and at an elevation, as a preliminary to the study of aërial navigation. 2000 w. Génie Civil—Feb. 24, 1900. No. 33206 D.

Artillery.

Modern Field Artillery. Illustrations of modern field guns, their carriages and equipments, with descriptions. 3500 w. Engng—March 2, 1900. Serial. 1st part. No. 32978 A.

Education.

Technical Education—An Economic Necessity. V. M. Alderson. Extracts from an address before the Central Ry. Club. 3500 w. Am Mach—March 29, 1900. No. 33183.

Indexing.

Decimal Indexes of Mechanical Literature. Illustrated letter, from Albert B. Herrick, describing a combination of decimal indexing and filing methods, found useful for many specialties. 1000 w. Eng Rec—March 10, 1900. No. 32-967.

Industries.

Economic and Labour Factors in the Distribution of Industries. John Richards. A discussion of the effects of trusts and protection as opposed to the laws of industrial evolution. 3500 w. Engineering Magazine—April, 1900. No. 33300 B.

Laboratory.

The Engineering Laboratory of the Technical High School at Hanover (Das Ingenieurlaboratorium der Königlichen Hochschule zu Hannover). F. Frese. A very full account of this completely equipped mechanical laboratory, with plans of the buildings, and illustrations of apparatus. Two articles. 8000 w. Zeitschr d Ver Deutscher Ing—Feb. 17, 24, 1900. No. 33219 each D.

Liquid Air.

Facts versus Claims for Liquid Air. Hudson Maxim. Considers some of the claims, and the applications in which it is most likely to be of value. 2400 w. Sci Am—March 17, 1900. No. 33007.

Linde Liquid Air Machine at the University of Michigan. Alfred L. Davenport. Illustrated description of a machine recently added to the scientific apparatus of the university. 700 w. Eng News—March 8, 1900. No. 32936.

Liquid Air as an Explosive. An account of experiments at Vienna, with the conclusions. 700 w. U. S. Cons Rpts. No. 673—March 9, 1900. No. 32896 D.

Liquid Atmospheric Air (Ueber Flüssige Atmosphärische Luft). Franz Walter. A general account of the method of producing liquid air, and a description of the phenomena of intense cold produced by it. Its practical applications are stated to be limited. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—March 2, 9, 1900. No. 33238 each B.

Prof. Pictet's Experiments With Liquid Air. Illustrated description of experiments with liquid air and the separation into its constituents, by which these gases are obtained in large quantities at low cost. 2200 w. Sci Am—March 31, 1900. No. 33367.

MINING AND METALLURGY

COAL AND COKE.

Bear Island.

The Coal Deposits of Bear Island (Die Kohlenlager der Bäreninsel). H. Möllman. A brief account of the important coal deposits of the island, which lies in the Arctic ocean between Norway and Spitzbergen. 1200 w. Glückauf—March 10, 1900. No. 33266 B.

Cape Breton.

Notes on the Deposition and Development of the Glace Bay Coal Seams. S. F. Kirkpatrick. From a paper read before the Applied Science Soc. of McGill Univ. Describes the deposits and method of mining. 2000 w. Can Engr—March, 1900. No. 33001.

Coal Resources.

Our Coal Resources and Consumption —A Reconsideration of Some Estimates. Considers the question of the quantity of coal in Great Britain, examining information given by Profs. Edward Hull and Stanley Jevous. 2000 w. Jour Gas Lgt —Feb. 20, 1900. Serial. 1st part. No. 32821 A.

Coke Making.

Time in Coke Making. William Gilbert Irwin. Brief account of experiments along this line. 900 w. Eng & Min Jour—March 3, 1900. No. 32850.

Connellsville.

Development of the Connellsville Coke Region. W. G. Irwin. A brief historical account of the industry. 1100 w. Eng & Min Jour—March 24, 1900. No 33135.

Face Mining.

Mining Coal at the Face. J. T. Beard. Points in regard to working which must be carefully considered to secure economy and safety. Ill. 4500 w. Mines & Min—March, 1900. No. 32781 C.

Lievin Colliery.

Continuation of the Pas-de-Calais Coalfield. M. A. Simon. From a communication to the Soc. Ind. Min. An illustrated account of exploring works recently carried out with the object of proving that the coal measures extend beyond the conceded portion and at a depth that can be reached by present methods of working. 3000 w. Col Guard—Feb. 16, 1900. No. 32788 A.

Limburg.

The Hard-Coal Basins in the Holland Province of Limburg (Das Steinkohlenbecken in der Holländischen Provinz Limburg). Franz Büttgenbach. A brief description of the Limburg mines, and the influence which their development will have upon the German coal trade. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 17, 1900. No. 33258 B.

New South Wales.

Coal Mining in New South Wales. Harrison F. Bulman. Part first gives the history and geology, with maps. 1700 w. Col Guard—Feb. 23, 1900. Serial. 1st part. No. 32872 A.

New Zealand.

Coal on the Cape Colville Peninsula. Describes the deposits, which are of more interest from a geological than from an economic point of view. 2500 w. N Z Mines Rec—Jan. 16, 1900. No. 33024 B.

See Electricity, Electro Physics.

COPPER.

British Columbia.

Prospects on Howe Sound, West Coast. W. M. Brewer. Describes this property, examined by the writer, and states the conclusions. 1500 w. Eng & Min Jour—March 17, 1900. No. 33074.

Idaho.

The Seven Devils Mining District, Idaho. William Beals, Jr. An interesting description of these copper deposits. Ill. 3000 w. Eng & Min Jour—March 24, 1900. No. 33133.

Supply.

The World's Supply of Copper. Frederick H. Hatch. The second portion of Dr. Hatch's paper is devoted to the production of all the districts not included in the United States, Portugal, and Japan; these having been treated in the previous part. 6000 w. Engineering Magazine—April, 1900. No. 33297 B.

GOLD AND SILVER.

Africa.

Macombe's Country (South of the Zambesi), Its Ancient Goldfields and Industrial Resources. Dr. Carl Peters. Ininteresting descriptive account, with discussion. 6400 w. Jour Soc of Arts—March 9, 1900. No. 33098 A.

British Columbia.

Mining Development on Vancouver Island in 1899. W. M. Brewer. Report of work and results. 1200 w. Eng & Min Jour—March 10, 1900. No. 32923.

The Trout Lake District. R Leckie-Ewing. Information concerning the mineral possibilities of this section, with illustrations. The characteristic ore is argentiferous galena, with which is associated grey copper and gold. Other minerals are present also. 1600 w. B C Min Rec—March, 1900. No. 32917 C.

Van Anda, Texada Island, B. C. Illustrated description of the properties of the Van Anda Copper and Gold Company. 2400 w. Eng & Min Jour—March 3, 1900. No. 32851.

Butte.

Butte Mining District. Arthur Lakes. Its geology and history and a description of the various ores from which its output is derived. Ill. 2700 w. Mines & Min—March, 1900. No. 32779 C.

California.

Cheap Mining and Milling at the Spanish Mine. Horace F. Brown. An account of a California gold mine and its working of low-grade ore. Ill. 1500 w. Min & Sci Pr—March 24, 1900. No. 33188.

Cape Nome.

The Gold Sands of Cape Nome. Angelo Heilprin. An interesting account of this mining district, giving its history, and describing the deposits and workings. Ill. 3700 w. Ap Pop Sci M—April, 1900. No. 33176 C.

Concentrating Plants.

New Bunker Hill and Sullivan Mill. An illustrated description of how one of the largest concentrating plants was built in four months. 800 w. Mines & Min—March, 1900. No. 32778 C.

Custom Mill.

The Montana & Denver Reduction Company's Mill at Bearmouth, Montana. Fred D. Smith. An illustrated account of this mill and the conditions that led to its erection. 1800 w. Eng & Min Jour—March 24, 1900. No. 33134.

Dredging.

A Modern Dredger Mining Plant. Illustrates and describes dredgers the motors of which are operated by alternating current. 700 w. Min & Sci Pr—March 24, 1900. No. 33187.

Gold Dredging. R. H. Postlethwaite. Discusses the conditions it is necessary for a dredge to fulfill in order to operate successfully. 2200 w. Mines & Min—March, 1900. No. 32777 C.

Gold-Dredging in New Zealand, Victoria, and New South Wales. George Robson. Read before the New South Wales Chamber of Mines. Descriptive paper, with discussion. 3300 w. N Z Mines Rec—Jan. 16, 1900. No. 33025 B.

Precipitation.

Successful Precipitation from Solutions Weak in Cyanide. Matt W. Alderson. An account of successful precipitation with hardly more than a trace of cyanide. 2300 w. Min & Sci Pr—March 24, 1900. No. 33186.

Siliceous Ores.

Wet Crushing and Cyaniding the Siliceous Ores of the Black Hills, South Dakota. John M. Henton. Describes the practice and gives table showing the conditions of the solutions and the precipitation during the month of Jan., 1900. 1100 w. Min & Sci Pr—March 10, 1900. No. 33014.

Transvaal.

The Transvaal Mining Industry for the Second Half of 1899. An account of the conditions and operations of the mines, touching on the political phases only so far as necessary to explain their influence on the industry. Also editorial. 4800 w. Eng & Min Jour—March 10, 1900. Serial. 1st part. No. 32920.

Washington.

The Mountain Lion Mine, Republic, Washington. M. H. Joseph. Information of a valuable mine, with illustrations. 2000 w. Eng & Min Jour—March 10, 1900. No. 32921.

IRON AND STEEL.

Armor Plates.

Armor Plates for the United States Navy. Reviews the history of the conflict between Congress, the government officials, and the manufacturers, during the last thirteen years, as given by the Am. Ir. and Steel Assn. 6200 w. Engr Lond—March 16, 1900. No. 33147 A.

Blast Furnaces.

Comparison of American and British Blast Furnace Practice. T. B. Rogerson. Read before the West of Scotland Ir. and Steel Inst. Describes the methods of work in Scotland and the United States, and form a comparison. 4000 w. Col Guard—March 16, 1900. No. 33143 A.

Brown Ores.

Some Notes on the Brown Iron Ores of Georgia. S. W. McCallie. Illustrates and describes the deposits and manner of working. 1500 w. Eng & Min Jour—March 3, 1900. No. 32849.

Carburized Irons.

New Reagents for the Micrographic Study of Carburized Irons. F. Osmond and G. Cartraud. Gives results of investigations. 800 w. Metallographist—Jan., 1900. 32825 E.

Converter.

A Study of the Thomas Converter (Etude sur le Convertisseur Thomas). A. Spilberg. A general discussion of the form, dimensions and accessories of a 12 ton basic converter. 800 w. Rev Univ des Mines—Feb., 1900. No. 33289 G.

Foundry Irons.

See Mechanical Engineering, Machine Works and Foundries.

Furnaces.

Reverberatory Furnaces. R. H. Palmer. Considers two kinds of reverberatory furnaces, one using a blast, the other natural draft. Ill. 2700 w. Foundry—March, 1900. No. 32830.

Italy.

The Iron and Steel Industry of Italy. Interesting particulars in regard to the progress and development. 3000 w. Ir Age—March 15, 1900. No. 33006.

Iron Markets.

The Competitors for the World's Iron Markets in 1899. J. S. Jeans. A comparison of the exports of 1899 of Great Britain, Germany, France, Belgium, and the United States. 2500 w. Ir Age—March 29, 1900. No. 33179.

Iron Works.

See Mechanical Engineering, Machine Works and Foundries.

Nickel Steel.

On the Position of the Points of Magnetic Transformation of Nickel Steels. L. Dumas, in *Comptes Rendus*. An account of investigations carried on at the Impley Works. 700 w. Metallographist —Jan., 1900. No. 32829 E.

Progress.

Iron and Steel—British and American. Editorial comment on the particulars of the iron industry in the United States as compiled by J. M. Swank, making comparison with Great Britain. 3200 w. Engng—March 16, 1900. No. 33146 A.

The Growth of the Iron Industry in the United States. F. W. Taussig. Abstract of a paper in *The Quarterly Journal of Economics*. An outline of the factors that have influenced this industry and caused the almost marvelous development. 1500 w. Col Guard—March 16, 1900. No. 33142 A.

Steel.

The Manufacture of Steel on the Basic Open-Hearth. Thomas Turner. Read before the West of Scotland Ir. and Steel Inst. Gives suggestions of value in steel making, and some results obtained by the basic open-hearth process, considering the different stages of the practice. 2800 w. Col Guard—Feb. 16, 1900. Serial. 1st part. No. 32790 A.

Transformations.

On the Changes of State in Iron and Steel. H. Le Chatelier, in *Comptes Rendus*. A study of the transformations due to temperature changes. 800 w. Metallographist—Jan., 1900. No. 32828 E.

MINING.

Geology.

Geological Notes from Denver, Colorado, to El Paso, Texas. Illustrated description. 2500 w. Mines & Min—March, 1900. No. 32783 C.

Inclines.

Inclined Planes (Les Plans Inclines). H. Ghysen. A discussion of the essentials in the construction of inclined planes in mines with regard to safety, including friction brakes, safety appliances, etc. 2500 w. 1 plate. Rev Univ des Mines—Feb., 1900. No. 33290 G.

Mining Improvements.

Improvements in Hauling, Winding and Loading. After extracts by *Glückauf* from the official report, "Versuche und Verbesserungen beim Bergwerksbetriebe in Preussen wahrend des Jahres 1898." Descriptive. 2500 w. Col Guard—Feb. 23, 1900. No. 32874 A.

Mine Power.

See Electrical Engineering, Power.

Mine Roads.

Mine Roads and Tracks. H. L. Auchmuty. The importance of good roads for securing economical handling of the mine products. The material, grades, weight of rail and size of ties, drainage, switches, curves, etc. 5000 w. Mines & Min—March, 1900. No. 32776 C.

Power.

Utilizing for Power the Descent of Gob Material. M. Berne. From a communication to the Société de l'Industrie Minérale. Describes the installation at the Saint-Etienne colleries, in which compressed air is used as a vehicle of the power. Ill. 3000 w. Col Guard—March 2, 1900. No. 32977 A.

Props.

Pit Props and Their Setting. J. Dickinson. Paper read before the Manchester Geol. Soc. On the strength of timber and setting of props, giving opinions of investigators, deductions and comparisons. 5000 w. Ir & Coal Trds Rev—Feb. 23, 1900. No. 32868 A.

Rope Haulage.

The Cost of Rope Haulage in Underground Workings (Die Betriebskosten der Unterirdischen Seilförderungen). An exhaustive review of the cost of rope haulage in the Ruhr district, as compared with animal power or electricity. 7500 w. 3 plates. Glückauf—Feb. 10, 1900. No. 33262 B.

Safety Door.

An Improved Safety Door for Mine Shafts (Ueber Einen Neuen Sicherheits-

Schachtsverschluss). The sliding door is operated automatically by levers actuated by the wheels of the car. 800 w. 1 plate. Glückauf—Feb. 24, 1900. No. 33264 B.

Safety Lamps.

Testing Interior Igniters for Safety Lamps. Bergassessor Balzer, in *Oesterreichische Zeitschrift für Berg Hütten und Salinenwesen.* Illustrates and describes experiments made to ascertain to what extent the lamps are liable to flare when lighted by percussion igniters in a fiery atmosphere, and so produce explosions. 1800 w. Col Guard—Feb. 16, 1900. No. 32789 A.

Shafts.

An Improvement in the Kind-Chandron Shaft-Sinking Apparatus (Ueber Neuerungen beim Kind-Chaudrouschen Abteufverfahren). With illustrations of an improved steel boring tool, and a suspended bucket dredge, as employed in sinking shafts in Belgium. 800 w. 1 plate. Oesterr Zeitschr f Berg u Hütten wesen—Feb. 24, 1900. No. 33260 B.

Improved Platform for Lining a Sinking Shaft. Plan and vertical section with description and statement of advantages. 1000 w. Col Guard—March 9, 1900. No. 33034 A.

Shafts and Shaft Machinery. A. S. Boucher. Read before the N. S. W. Chamber of Mines. Considers the kind of shaft, shape, size, and position, the timbering, equipment, etc. 3900 w. Aust Min Stand—Feb. 1, 1900. No. 32904 B.

The Sinking of Shaft II. of the Osterfeld Mine (Das Abteufen des Schachtes II. der Zeche Osterfeld im Deckgebirge). A description of the method adopted in one of the coal mines in the Ruhr district near Oberhausen, in sinking a shaft through sand, gravel, and marl. 1000 w. Glückauf—Feb. 17, 1900. No. 33263 B.

Surveys.

Underground Surveys and Their Connection with the Surface by the Transit Method. E. H. Liveing. An illustrated description of a method particularly suited to deep shafts. 2200 w. Mines & Min—March, 1900. No. 32782 C.

Tipping.

A Tipping Device for Buckets (Eine Aussturzvorrichtung für Kästen in Führungen). A. Lukaszewski. Illustrating and describing an arrangement by which the tipping and emptying of a mine bucket is accomplished by pins seating in an inclined support. 800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 24, 1900.—No. 33259 B.

Tipping Arrangement for Kibbles Working in Guides. A. Lukaszewski. From *Zeitschrift für das Berg und Hüttenwesen.* Brief illustrated description of a contrivance used in a colliery in Hungary. 800 w. Ir & Coal Trds Rev—March 2, 1900. No. 32981 A.

Transport.

Wheel and Pack Transport for Mines. C. C. Longridge. Considers the systems of transport and the kind of transport, discussing the advantages under various conditions. 3000 w. Engr, Lond—March 9, 1900. No. 33029 A.

Under Sea.

Under-Sea Mining at Arnao, Spain. Alphonse Dory. From a communication to the Société des Ingenieurs des Mines du Hainaut. Describes the surface and underground works. Ill. 3000 w. Col Guard—March 16, 1900. No. 33141 A.

Ventilation.

Fan Speed and Pressure Recorders. Describes two appliances used at the Saint-Etienne collieries, which have given entire satisfaction. Ill. 1400 w. Col Guard—March 9, 1900. No. 33036 A.

Winding.

Winding from Deep Mines. Illustrates and describes the system introduced at Dolcoath mine by its inventor, William Morgans. 1600 w. Engr, Lond—March 16, 1900. Serial. 1st part. No. 33152 A.

MISCELLANY.

Crusher.

A New Form of Roll Crusher for Rock and Ore Crushing. Illustrations showing the design and construction of an improved type, called the centrifugal roll crusher. Details of its efficiency. 900 w. Eng News—March 8, 1900. No. 32937.

Magnesite.

The Magnesite Industry. Solon J. Vlasto. Concerning the production and uses. Ill. 1200 w. Eng & Min Jour—March 10, 1900. No. 32922.

Minerals.

Simple Tables for the Determination of the Common or Economically Important Minerals. Alfred J. Moses. Gives a tabulation of the important minerals by a few easily made tests and external characters. 1600 w. Sch of Mines Qr—Jan., 1900. No. 33018 D.

Nova Scotia.

New Mineral Discoveries in Nova Scotia. Edwin Gilpin, Jr. Read before the Nova Scotian Inst. of Science. Extract concerning coal, iron ore, etc. 2200 w. Col. Guard—March 9. 1900. No. 33037 A.

Oil.

The California Oil Industry. Ernest

Horsfall Rydall. An account of the oil wells at Los Angeles and other points, and the excitement attending this discovery. Ill. 1300 w. Min & Sci Pr—March 17, 1900. No. 33099.

Separator.

A Centrifugal Separator (Schlenderseparator). L. Kleritj. Illustrating and describing an improved hydraulic centrifugal machine for separating various ores and earths according to density and size of particles. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 10, 1900. No. 33261 B.

Tin.

The Blue Tier (Tas.) Tin Dykes. H. Grant. Information concerning this important discovery and the working of the deposits. 900 w. Aust Min Stand—Feb. 15, 1900. No. 33182 B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in January. Detailed list and classified summary. 2500 w. R R Gaz—March 9, 1900. No. 32934.

Freight Speeds.

Freight Train Speeds on the Northern Pacific. Discussion by E. H. McHenry, chief engineer of the road named. Also editorial. 2000 w. R R Gaz—March 2, 1900. No. 32769.

Great Central.

The New Line in London. W. B. Paley. An account of the first half year's working of the Great Central Ry. which is rather discouraging. 900 w. R R Gaz—March 30, 1900. No. 33198.

Parcels.

The Handling and Conveyance of Small Consignments. Discusses the report of Mr. Jasper, general goods manager of the North-Eastern Railway of Great Britain, and the advisability of carrying small consignments by passenger train. 2000 w. Transport—Feb. 16, 1900. No. 32824 A.

Russia.

Ten Years' Railroad Progress in Russia. Information from a recent statement made by the Minister of Finance on the economic condition of the country. 1600 w. R R Gaz—March 30, 1900. No. 33304.

Statistics.

The Railways of Germany, England, and France in 1895-1897 (Die Eisenbahnen Deutschlands, Englands, und Frankreichs in den Jahren 1895-1897). A tabulated comparison of equipment and operation of the three countries, showing the increase in Germany over England and France. 1500 w. Glückauf—Feb. 24, 1900. No. 33265 B.

FINANCIAL.

Dividends.

New Railroad Dividends. Editorial discussion of recent declarations, and the roads announcing an increase. 1200 w. R R Gaz—March 2, 1900. No. 32772.

Expenses.

Railway Maintenance of Way Expenses. Gives a table showing the relation of the maintenance of way expenses to the mileage, train mileage and operating expenses on a number of railways, with comments. 700 w. Eng News—March 8, 1900. No. 32941.

MOTIVE POWER AND EQUIPMENT.

Compressed Air.

Applications of Compressed Air in Railroad Shop Practice. Edward C. Schmidt. Extract from an address before the St. Louis Ry. Club. Notes some of the applications and the saving effected. 1800 w. R R Gaz—March 30, 1900. No. 33302.

Eccentrics.

An Improvement in Locomotive Eccentrics. Illustrated description of an improved style of split eccentric used by the Brooks Locomotive Works. 450 w. Am Engr & R R Jour—March, 1900. No. 32760 C.

Equipment.

The Increased Cost of Railway Equipment. Tabulated information of prices in 1898 and 1900 for material entering into the construction and repair of locomotive and car equipment. 1000 w. Ry Age—March 9, 1900. No. 32995.

Hospital Train.

The Princess Christian Hospital Train for South Africa. H. J. Shepstone. Illustrated description of an efficient train built in quick time. 1200 w. Sci Am—March 24, 1900. No. 33091.

Locomotive Boilers.

Supporting Rear Ends of Locomotive Boilers. Discussion of methods used, considering the best plan is to support the boiler by the mud ring, or by the mud ring and by lateral plate braces. Ill. 700 w. Am Engr & R R Jour—March, 1900. No. 32761 C.

Locomotive Design.

Some Questions in Locomotive Design. William G. Raymond. A study of a diagram of locomotive horse-power curves, and the questions brought out. 2000 w. R R Gaz—March 30, 1900. No. 33199.

Locomotive Performance.

A Run on the North-Eastern Railway. Charles Rous-Marten. An account of a run with one of the new locomotives recently built for this road, showing a highly creditable performance. 1500 w. Engr, Lond—Feb. 23, 1900. No. 32875 A.

Locomotives.

A Mogul Engine for the New York Central. Engraving and specifications. 300 w. R R Gaz—March 30, 1900. No. 33197.

Baldwin Engines for Paris Exhibition. Described and illustrated by half tones. 400 w. Loc Engng—March, 1900. No. 32752 C.

Express Passenger Engine, North-Eastern Railway. Engraving, sectional drawings and dimensions of an engine for work of heaviest and fastest description. 700 w. Engr, Lond—March 9, 1900. No. 33031 A.

Four-Coupled Crampton Engines. W. B. Paley. Illustrated account of engines built in 1861 and 2. They were designed for the London, Chatham & Dover R. R. 700 w. R R Gaz—March 9, 1900. No 32933.

Mr. Ivatts' Newest Great Northern Engines. Charles Rous-Marten. An account of runs made with recently built engines and descriptions of the types. Ill. 2600 w. Engr, Lond—March 16, 1900. No. 33151 A.

Narrow-Gauge Tank Locomotives. Illustrated description of a locomotive for the Londonderry and Lough Swilly Ry. of Ireland. 800 w. Engng—Feb. 23, 1900. No. 32870 A.

New Consolidation Locomotives for the Lake Shore and Michigan Southern. Descriptive specifications, important features and engraving. 800 w. R R Gaz—March 2, 1900. No. 32771.

New Express Locomotives (Nouvelles Machines d'Express). M. Desdouits. An illustrated description of the new simple expansion engines with piston valves, constructed for the French State Railways. Serial. Part I. 5000 w. 5 plates. Rev Gen de Chemins de Fer—March, 1900. No. 33267 G.

New Locomotives of the Chicago, Burlington and Quincy. Description and drawings of new freight locomotives and switchers. 1800 w. R R Gaz—March 30, 1900. No. 33301.

Recent Cooke Locomotives. Illustrated description of two recently completed engines having points of interest. 1600 w. Ry & Engng Rev—March 24, 1900. No. 33164.

Ten-Wheel Passenger Locomotive; Northeastern Ry. (England). Illustrated description of a large and heavy engine for hauling fast and heavy passenger trains. 1300 w. Eng News—March 29, 1900. No. 33191.

Lubrication.

Lubrication of Car Journals. Explains some of the causes of hot journals, illustrating the wear, with suggestions for the operation and care of cars. 1800 w. R R Gaz—March 23, 1900. No. 33109.

Models.

Early Models of Railways and Locomotives. An account of models exhibited as far back as 1808. 3700 w. Engr, Lond—Feb. 23, 1900. No. 32878 A.

Passenger Cars.

Passenger Cars for the Buffalo, Rochester and Pittsburg Railroad. Illlustrations and descriptions of interesting features of these cars. 1700 w. R R Car Jour—March, 1900. No. 32996.

Train Heating.

New Methods of Heating Railway Trains (Méthodes Nouvelles de Chauffage des Trains). A description of the methods employed on the various railways of France; both hot-water and steam are used. 3500 w. Revue Technique—Feb. 25, 1900. No. 33216 D.

Train Lighting.

Electric Lighting of Railway Carriages. Illustrates and describes a system recently tried on the Paris, Lyons, and Mediterranean. 1400 w. Engr, Lond—March 2, 1900. No. 32980 A.

Electric Train Lighting. Alton D. Adams. Briefly describes the methods tried with success. 1500 w. Sci Am—March 3, 1900. No. 32754.

Trucks.

Symons Boltless Cast Steel Truck. Illustrated description of a truck made of three members and no bolts. 500 w. Loc Engng—March, 1900. No. 32753 C.

Valve Gear.

The Hardie New Valve Gear. Illustrated description with tabulated results of distribution obtained. 400 w. R R Gaz—March 9, 1900. No. 32935.

Wheels.

Slid-flat Car Wheels. F. B. Farmer. Abstract of paper presented at Jan. meeting of the Northwest Railway Club. Discussing the causes. 1800 w. R R Gaz—March 9, 1900. No. 32932.

The Wear of Wheels on Sharp Cornered Rails. Editorial giving the history and development of the Am. Soc. C. E. rail section, with letter of inquiry, and letters showing the practice of different roads. 4800 w. Eng News—March 29, 1900. No. 33193.

NEW PROJECTS.

Africa.

The Cape-to-Cairo Project. J. Hartley Knight. A fully illustrated article treating of the growth of Mr. Rhodes' imperial conception, together with an account of the progress of the work. 4000 w. Engineering Magazine—April, 1900. No. 33293 B.

Asia Minor.

Railroad Construction in Asia Minor. Map and brief account of important extension uniting the Persian Gulf with Europe. 350 w. U. S. Cons Repts, No. 665—Feb. 28, 1900. No. 32745 D.

The Railway Struggle in Asia Minor. Editorial discussion of new railway projects under the control of Germany and of Russia. 1300 w. Engr, Lond—March 16, 1900. No. 33150 A.

Azores.

Proposed Railway in the Azores. Summary of a contract for the building and equipping of a modern narrow-gauge railway to connect Ribeira Grande, and Furnas, a local resort noted for its hot springs. 1200 w. U. S. Cons Repts, No. 681—March 19, 1900. No. 33053 D.

India.

New Projects of Railway Communication with India. J. M. Maclean. Discusses the great changes brought about by the construction of new roads in Russia, Siberia, and other countries, and the inaction of England. Also general discussion. 10000 w. Jour Soc of Arts—Feb. 16, 1900. No. 32774 A.

Switzerland.

Recent Railway Projects in Switzerland (Neue Schweizerische Eisenbahnprojekte). R. Moser. A review of a number of proposed railway schemes, including, among others, the railway and tunnel over the Splügen Pass. Three articles. 7500 w. Schweizerische Bauzeitung—Feb. 24, March 3, 10, 1900. No. 33246 each B.

PERMANENT WAY AND FIXTURES.

Address.

Maintenance of Way Problems. J. F. Wallace. Presidential address before the American Assn. A review of progress. 1800 w. Ry Age—March 16, 1900. No. 33083.

Ballasting.

Ballasting. Committee report presented to annual convention of American Ry. Engng. and Maintenance of Way Assn. 10000 w. Ry Age—March 16, 1900. No. 33085.

Chicago Shops.

Chicago and Northwestern Shops at Chicago. An illustrated description of extensive improvements being carried out. 1000 w. Am Engr & R R Jour—March, 1899. Serial. 1st part. No. 32762 C.

Maps.

Right of Way Maps. Concerning a fine set just completed by the engineering department of the Chicago & West Michigan and the Detroit, Grand Rapids and Western Rys. 5000 w. Ry Age—March 16, 1900. No. 33087.

Mountain Railway.

Where Grades and Curves Prevail. Description and views of an extension recently made to the Alamogordo and Sacramento Railway. 600 w. Ry Age—March 16, 1900. No. 33084.

Rail Creeping.

The Creeping of Rails on the Eads Bridge, St. Louis. Letter from N. W. Eayrs, the superintendent of the structure, concerning the amount of rail creeping and means adopted to accommodate it. 700 w. Sci Am—March 24, 1900. No. 33092.

Rails.

"Brittle" Rails and Phosphorus Content. Editorial discussion of complaints and of the cause of the trouble. 2000 w. R R Gaz—March 30, 1900. No. 33303.

Railway Bridges.

See Civil Engineering, Bridges.

Shops.

The Oelwein Shops. An illustrated description of the new plant of the Chicago Great Western Ry., with editorial comment on interesting features. 5500 w. Ry Age—March 2, 1900. No. 32847.

Signals.

Pipe-Connected Signals for Mechanical Interlocking. G. S. Pfasterer. Read before the Ry. Sig. Club. Favoring the pipe-connected signal, and reporting the satisfactory use on the Chicago & Eastern Illinois R. R. 1200 w. Ry & Engng Rev—March 10, 1900. No. 32997.

Virgillito's Automatic Electric Block-Signal System (Virgillito's Elektrisch Selbstthätige Eisenbahn-Blocksignale). L. Kohlfürst. The equilibrium of two opposing currents is disturbed by the entrance of a train on the block. 2500 w. Elektrotech Zeitschr—March 8, 1900. No. 33280 B.

Stations.

New Union Passenger Station at Springfield, Ill.; Illinois Central R. R. Description with two-page plate. 1700 w. Eng News—March 1, 1900. No. 32-768.

Recent Passenger Stations (Ueber Neuere Personenbahnhöfe). H. Hoogen. With plans of the new stations at Altona, Kiel, Danzig, Coblenz, and other German cities, and a general discussion of station arrangements and facilities. 5000 w. Glaser's Annalen—Feb. 15, 1900. No. 33251 D.

The New Texas and Pacific Station at Fort Worth. Brief illustrated description. 300 w. Ry Age—March 16, 1900. No. 33086.

The Recent Improvements of the Stations of the Kaiser Ferdinand Northern Railway (Ueber Neuere Erweiterungsbauten auf Stationen der Kaiser Ferdinands-Nordbahn). Ernst Reitler. With numerous illustrations of new stations, together with plans and interior views of the locomotive works at Ostrau in Moravia. 4000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 16, 1900. No. 33235 B.

The South Terminal Station, Boston, Mass. Discussion of paper by George B. Francis. 2500 w. Pro Am Soc of Civ Engs—Feb., 1900. No. 32841 E.

Switching.

Electro-Pneumatic Switching and Signaling System at the South Boston Terminal Station. Illustrated description. 1200 w. Sci Am—March 3, 1900. No. 32755.

TRAFFIC.

Freight.

French and German Practice in Grouping Small Shipments of Freight. Abstract of a paper to be presented at the International Ry. Congress at Paris. by Mr. Mange. 1200 w. R R Gaz—March 16, 1900. No. 33078.

Freight Rates.

Relative Freight Rates on Large and on Small Shipments. Editorial discussion of the principles that should govern in the making of rates. 2700 w. Eng News—March 1, 1900. No. 32766.

STREET AND ELECTRIC TRAMWAYS

Berlin.

The Applicability of Electric Driving to City Railways (Obauf Stadtbahnen der Elektrische Betrieb Eingefuhrt Werden Murs). H. Pforr. Discussing especially the case of the Berlin elevated railway, with diagrams showing the relation of speeds, stops, and efficiency. 4000 w. Glaser's Annalen—March 1, 1900. No. 33257 D.

Boston Elevated.

The Elevated Structure of the Boston Elevated Railway. Illustrated description of the foundations and metal work of a double-track road, showing all the details, and explaining the method of erection. 3800 w. Eng Rec—March 17, 1900. No. 33045.

The System of the Boston Elevated Railway Co. C. B. Fairchild. Illustrates and describes the line, the subway, the organization, the mechanical and electrical features and methods. 3800 w. St Ry Rev—March 15, 1900. No. 33002 C.

Brooklyn Heights.

Electrical Engineering on the Brooklyn Heights Railroad. Information concerning the building of the power houses and the keeping up the line voltage. Ill. 1000 w. R R Gaz—March 16, 1900. No. 33-077.

Cable System.

The Cable Tramway System of Edinburgh. A comprehensive illustrated description of an installation having many improvements and interesting features. 10000 w. Tram & Ry Wld—March 8, 1900. No. 33114 A.

Compressed Air.

Traction With Compressed Air (La Traction à Air Comprimé). M. A. Monmerqué. A general account of the Mekarski system as employed in Paris since 1876. 5000 w. Rev Gen de Chemins de Fer—March, 1900. No. 33268 G.

Earning Power.

How to Determine the True Net Earning Power of Street Railway Properties. Edward E. Higgins. Describes the physical and financial features of an assumed property, as an illustration of principles, showing how the true earning power may be determined. 4700 w. St Ry Jour—March 3, 1900. No. 32900 D.

Electric Railway.

The Akron, Bedford and Cleveland Electric Railway. Illustrated description of the road and its equipment. 2000 w. Elec Rev, N. Y.—Feb. 28, 1900. No. 32-758.

Electric Traction.

Notes on Electric Traction Under Steam Railway Conditions. Edward C. Boynton. An interesting paper discussing the question of local passenger service, the increase in traffic, and reduction of operating expenses. 8500 w. Trans Am Inst of Elec Engs—Jan., 1900. No. 32912 D.

Electrolysis.

The Effect of Joint Resistance on Railway Electrolysis. A. A. Knudson. Facts from experience showing that the independent return is not always a cure for electrolysis, and considering the only reliable remedy to be double overhead or underground construction. 1400 w. Am Elect'n—March, 1900. No. 32858.

Geneva.

Electric Street Railway in Geneva. Information concerning a railway projected by a citizen of San Francisco, and constructed by an American electrical engineer. 700 w. U. S. Cons Repts, No. 688—March 27, 1900. No. 33165 D.

Hill-Side Tramway.

A Hill-Side Electric Tramway Near Rouen. An illustrated description of an interesting extension to the tramway system of Rouen. 1300 w. Tram & Ry Wld—March 8, 1900. No. 33115 A.

Indicators.

Electrical Indicators in the Boston Subway. Illustrates and describes an apparatus adopted to prevent accidents and facilitate the handling of crowds. 600 w. R R Gaz—March 23, 1900. No. 33-111.

Interurban.

The Rapid Railway—Detroit to Port Huron. Particulars concerning important extensions, and the facilities offered by this new road. 1500 w. R R Gaz—March 23, 1900. No. 33112.

Long Distance.

High Speed Three-Phase Railway from Toledo to Norwalk, Ohio. An illustrated account of this new 60 mile railway, soon to be opened. 4000 w. St Ry Jour—March 3, 1900. No. 32898 D.

Metropolitan Station.

Main Power Station and Transmission System of the Metropolitan Street Railway Company of New York. Illustrated detailed description of the main power station and its equipment and the distributing system. 8500 w. St Ry Jour—March 3, 1900. No. 32897 D.

Mountain Road.

The Jungfrau Three-Phase Electric Railway. Ernest Kilburn Scott. A very fully illustrated description of the latest development in mountain railroading in Switzerland. 4500 w. Engineering Magazine—April, 1900. No. 33296 B.

New Road.

The Milford, Attleboro and Woonsocket Street Railway. William D. Ennis. Describes this new road and its equipment and operation. Ill. 2500 w. Elec Wld & Engr—March 17, 1900. No. 33069.

Overhead.

The Construction of Overhead Equipments. A brief illustrated account of the work of construction of an overhead line for tramway work, with a view to pointing out some of the difficulties that may be encountered. 1900 w. Elec Rev, Lond—Feb. 23, 1900. Serial. 1st part. No. 32881 A.

Power Station.

The Kingsbridge Power Station of the Third Avenue Ry., New York City. Burcham Harding. Illustrated description of interesting features. 4000 w. Eng News—March 22, 1900. No. 33118.

Stray Currents.

The Action of Electric Tramway Currents on Submarine Telegraph Cables and Other Electric Circuits. Andrew Jamieson. Read before the Inst. of Engs. and Shipbuilders of Scotland. Deals with one of the causes of delay in the transmission of telegrams between England and Cape Town. Also editorial. Ill. 5400 w. Elect'n, Lond—March 2, 1900. No. 32883 A.

The Influence of Stray Currents from Electric Tramways Upon Magnetic Observatories (Untersuchungen des Einflusses der Vagabundirenden Ströme Elektrischer Strassenbahnen auf Erdmagnetische Messungen). J. Edler. A very full account of the investigations at the Potsdam observatory, with reproductions of the photographic records. 5000 w. Elektrotech Zeitschr—March 8, 1900. No. 33279 B.

Suburban.

A New England Suburban Railway. An illustrated description of the Exeter, Hampton and Amesbury street railway. 1600 w. St Ry Jour—March 3, 1900. No. 32899 D.

Suspended Road.

The Suspended Railway Between Barmen, Elberfeld, and Vohwinkel (Le Chemin de Fer Suspendu de Barmen-Elberfeld-Vohwinkel). Alfred Boudon. A very fully illustrated account of this overhead electric railway. The carriages are suspended from a single overhead rail, and the road follows in great part the river Wupper. 3000 w. Génie Civil—March 10, 1900. No. 33210 D.

Three-Phase.

Three-Phase Installation of the Newtown (Pa.) Electric Street Railway. Brief illustrated description. 700 w. St Ry Rev—March 15, 1900. No. 33-003 C.

Vienna.

The Track of the Vienna City Railway (Der Oberbau der Wiener Stadtbahn). Hugo Koestler. Giving details of the rails and joints and general track construction of the road. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—March 9, 1900. No. 33239 B.

BOOK REVIEWS

THE FILTRATION OF PUBLIC WATER SUPPLIES. By Allen Hazen, Assoc M. Am. Soc. C. E., etc. Third edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Limited. Cloth; 8vo.; pp. 321. Illustrated.

Mr. Allen Hazen is so widely known in the United States and Europe as an authority on the filtration of public water supplies, that a new edition of his book upon that subject is certain to be well received. Since the appearance of the first edition in 1895, scientific investigations have extended our knowledge of the purification of turbid waters, and Mr. Hazen has taken advantage of this recently acquired information to give his readers a discussion of the principal topics relating to the removal of excessive amounts of silt, clay, sand, etc. A chapter on the removal of iron from ground water has been supplied, as have several statistical tables and a description of the Albany, N. Y., filtration plant. The older portion of the book, dealing with the construction and operation of slow sand filters, has been retained and the original chapter on the relation between impure drinking water and disease has been rewritten. In the enlargement the scope and importance of the book have been greatly increased. To those persons who doubt the importance of pure water supplies or question the practicability of removing bacteria and other impurities by filtration, Mr. Hazen has given a strong answer. Of the half dozen works dealing with the subject, none is clearer in style or more essential in information. The book is handsomely illustrated and printed, and contains several appendices, and a valuable bibliography for the convenience of those who desire to study the subject further.

COPPER MANUAL. Copper Mines, Copper Statistics, Copper Shares, and a Summary of Information on Copper, etc. New York: D. Houston & Co., Metal Brokers. Volume 2, 1899.

The contents of the book are accurately described by the sub-title. While essentially devoted to statistical information concerning American copper mines and mining companies, on both the operative and the fiscal sides of their management, it contains also many general tables of production and prices in the United States and in Europe. It is handsomely printed, and is a useful book within the scope designed by its publishers.

HANDBOOK OF TESTING MATERIALS for the Constructor. Part I. Methods, Machines, and Auxiliary Apparatus. Two volumes: Vol. I., Text: Vol. II., Illustrations. By Professor Adolf Martens, Director of the Royal Testing Laboratories at Berlin and Charlottenburg. Authorized Translation and Additions, by Gus. C. Henning, M. E. New York: John Wiley & Sons. London: Chapman & Hall, Limited. 1899.

It is altogether unnecessary to speak of the importance and value of the monumental work which has been done by Professor Martens at the Charlottenburg Testing Laboratory, and this first portion of his treatise upon the general subject has been awaited with especial interest by constructors in the English-speaking countries.

There is probably no one subject in the domain of engineering in which such a thoroughly organised effort is being made at unification and systematisation as in the matter of methods of testing materials of construction, and both the author and the translator of these volumes have been active in the work, so that the book may fairly be considered as the latest expression of the results of that association.

Some general idea of the contents may be obtained when it is understood that they include an introductory essay upon the technological properties of materials in general, an exhaustive section on the whole subject of the resistance of materials, an examination of standard of quality for technological value of materials of construction, and a most complete and fully illustrated descriptive section, including practically all the machines which have yet been devised for the purposes of testing.

The thoroughness with which the work both of author and translator has been done can only be appreciated by an examination of the books themselves, and a further assurance of the value of the translation is had in the knowledge of the close association and friendship existing between the able director of the Charlottenburg laboratories and his friend and colleague in the Council of the International Association for Testing Materials.

THE

ENGINEERING MAGAZINE

VOL. XIX. JUNE, 1900. No. 3.

THE DEMONSTRATED SUCCESS OF THE SUBMARINE BOAT.

By Rear Admiral Philip Hichborn, Chief Constructor, U. S. Navy.

MY attention was first drawn to the question of the practical utility of submarine boats by the findings of the so-called "Endicott Board" in 1886. This Board was constituted under the Act of Congress of March 3, 1885, and was composed of prominent Army and Navy officers and civilians, with the Secretary of War as President, and was known under the act authorizing it as the "Board on Fortifications and Other Defenses." Its report was printed as Ex. Doc. 46 of the Forty-ninth Congress, last session, and in it, while the Board as a whole expressed the opinion that "Submarine boats have not passed the experimental stage and the Board has at present no recommendation to make in their regard," there appeared as an appendix to a report of a sub-committee—of which Col. Abbott of the engineers, and Commander, now Admiral. Sampson were members—a very exhaustive and complete history of the development of submarines.

The perfection of the submarine boat has a double interest—as a triumph in the adaptation of mechanical transport, and as a revolutionizing influence in naval tactics and strategy. France is keenly interested, Germany is investigating. England seems to be waiting developments in other navies. Admiral Hichborn, the leading American authority, tells what the United States have done. THE ENGINEERING MAGAZINE is happy in presenting his admirable review and analysis. It is a complete and authoritative summary of past work and present conditions.—THE EDITORS.

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Edward Everett Hale tells us that:

"Boards are long and narrow,
They are made of wood";

and while the reverend gentleman's definition is quite exact if judged by the occasional results of the work of Boards, it must be remembered that these results are oftener due to hampering conditions than to woodenness of individual members.

It is certain that the members of the Endicott Board were neither narrow nor wooden, and that its report was most judicious and valuable, although its recommendations in regard to mobile defenses received but little attention from Congress.

To one accustomed to the actions of Boards and to reading between the lines of a report, it was apparent that Gen. Abbott and Admiral Sampson desired to accentuate the probable value of submarines, although the Board as a whole could only be brought to an expression in regard to them which was the merest platitude. This desire was shown by the facts that the appendix on submarines was written by Capt. Maguire, Secretary to the Board; that the body of the report accentuates the necessity for securing an economic mobile defense of the coast; that the estimates and designs for coast-defense ships were unsatisfactory; and that no satisfactory method of securing the coasts without the aid of submarines was found, although the Board was emphatic in its decision that sea-going ships of the Navy should "act offensively and not be confined to the defense of ports."

The enormous stretch of our coasts, with their numerous attractive points for attack for an enemy, were described, and surface torpedo boats were recommended for their defense. Now it is clear that the providing of surface torpedo boats alone would furnish only a very unsatisfactory defense, since they can only hope for success under cover of darkness, and that the idea of providing enough armored ships for the local defense of the more important ports and important strategic points was impracticable on account of expense, even if the proper offensive use of the fleet were to be abandoned and it were degraded to local coast defense work. What then could be our resort?

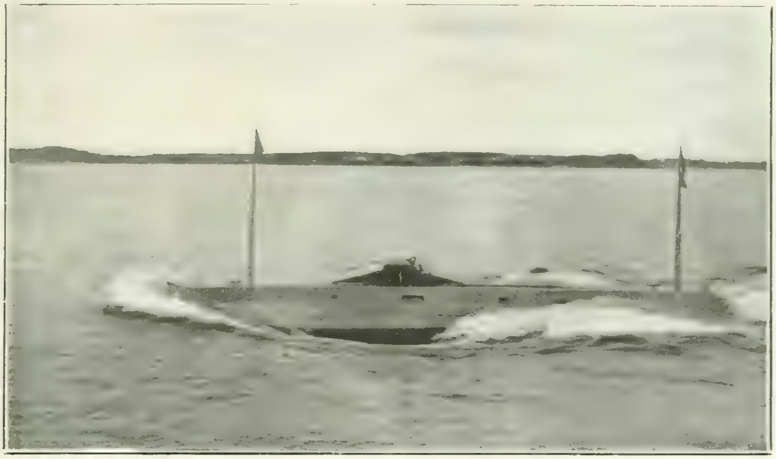
Evidently the answer in the report of Gen. Abbott and Admiral Sampson was intended to be: "Possibly submarines."

Naturally this matter interested me, and I investigated the history and development of the type, using the Board's study as a basis.

It appears that the art of brain-directed submarine navigation has been in process of development for at least three hundred years, and that many of the attempts to make it practicable would have been near enough to success to insure continued and logical effort in improvement, had it not been for the ultra-conservatism of seafaring folk. Curiously enough, automatic submarine navigation has had but a few decades of development, has met with but little obstruction from seamen, and has rapidly advanced to the high state of perfection that is shown in the automobile torpedoes of the present day.

A glance at the history of submarine boats is necessary in order to trace the course of development.

William Bourne, an Englishman, has the credit of operating the first submarine boat, as such, in contradistinction to a diving bell; but the records of his operations have been lost in the years since his work was done, rather more than three hundred years ago.



THE HOLLAND SUBMARINE BOAT RUNNING ON THE SURFACE.
This is the boat recently accepted by the United States Navy.

In 1624, the Hollander, Cornelius Van Drebbel, took twelve persons for an under-water run in his submarine boat worked by twelve pairs of sculls and carried "quintessence of air" for them to breathe—probably what we now call compressed air.

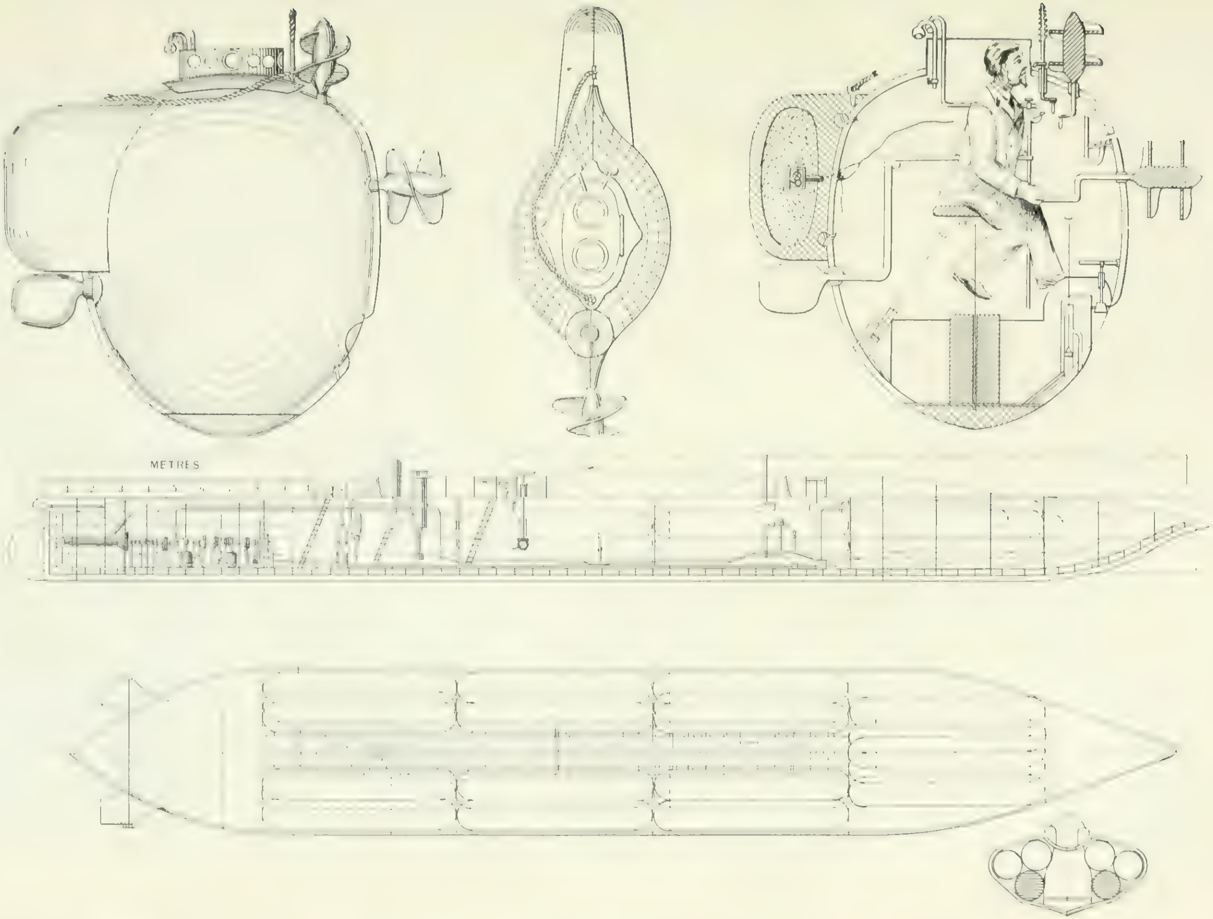
During the succeeding twenty years the history of submarine navigation was worked out, the main principles well grasped, and in 1653 a Frenchman, name unknown, built and operated a submarine boat at Rotterdam. Later in the century an Englishman named Day built and operated a submarine boat and is reported to have lost his life in her upon his second submerged run, through the crushing of the hull under pressure due to depth of water. I am inclined to think that the accident was a real one and that its deterrent effect accounts for the long hiatus in submarine-boat attempts that existed between the time of Day and that of the inception of Bushnell's boat in 1771.

If Day were really crushed in his boat, he has the unique distinction of being the only known victim of the dangers of submarine navigation, but this distinction depends upon the supposition that reports of submarine accidents were much more reliable two hundred and forty years ago than they have been for the last forty years, during which period there have been *authentic* newspaper reports of the loss of eighty-two lives in attempting submarine navigation in the United States. Fifty of these lives were not lost at all, and the other thirty-two, though lost in a boat designed to operate as a submarine, were all lost when, and apparently because, she was not so operating.

The design of Bushnell, of Connecticut, projected in 1771 and made operative in 1775, was for a small one-man-operated boat devised for work against ships at anchor. The boat possessed many of the features that are recognized to-day as essential for submarine navigation, notably buoyancy—*i. e.,* she was lighter than the water she displaced when submerged, with a fixed center of gravity and arrangements for compensating with water ballast for weights expended. She was forced under by a vertical propeller and driven forward by a horizontal one—both worked through cranks by the crew of one.

Her efficiency for the times was shown by Sergeant Lee, who took her under the Eagle frigate near Governor's Island, and who failed to secure his torpedo to the bottom of the ship because he forgot to make use of a detachable weight fitted for an anchor. This efficiency seemed to impress our forefathers—as evidences of greater efficiency fail to impress us of a later day—for more than twenty years after the failure to blow up the Eagle we find Washington writing to Jefferson and expressing the opinion that the submarine navigation was successful and that the lack of results was due to difficulty in finding men with sufficient brains and bravery to work the boat.

A dozen years after Washington wrote this letter, Fulton, in 1797, was pushing submarine navigation in France, for it must be remembered that he was a submarine-boat man before he took to steam-boating. Borrowing the ideas of Bushnell and applying them to more powerful craft, he made a long stride in the methods of under-water work. Ninety-eight years ago Fulton turned out his second twin-screw hand-worked submarine boat, made a submerged run of four hours and twenty minutes, placed a torpedo under a hulk and blew it up—and received the regular encouragement served out to people who are ahead of their time—obstruction tempered with neglect.



THE UPPER THREE FIGURES REPRESENT BUSHNELL'S SUBMARINE BOAT; THE LOWER ONES SHOW PLAN AND SECTION OF THE BRUN BOAT, "LE PLONGEUR," TESTED UNDER ADMIRAL BOURGOIS.

For nearly thirty years and until the day of his death—which must have brought with it a great sense of relief to the naval obstructionists of the day—Fulton was an ardent submarine man and his "Nautilus" was, for her time, as efficient as the "Holland" of to-day—and met with the same kind of encouragement.

To the credit of that wonderful man, Napoleon I., it must in justice be said that he appreciated what submarines meant, just as he appreciated breech-loading small arms. In both cases he submitted the designs to Boards, and in both cases the devices were condemned because the Boards were long, narrow, and wooden, and consequently failed to see the points in breech-loaders which were not recognized for fifty years and the points in submarine navigation which are not yet acknowledged. A curious illustration of the conservatism of naval opinion was given in a trial by Fulton of the effectiveness of torpedoes. He was to attack a U. S. ship and the Commander, Commodore Rogers, was to defend it. The Commodore rigged booms around his vessel so that he destroyed her mobility and usefulness as a fighting ship. He successfully defended his vessel, and instead of the result being looked upon as a triumph for the torpedo, since the defense nullified the fighting efficiency of the ship, it was hailed as a triumph of the ship, since the torpedo could not blow her up.

But the French did not wholly abandon the submarine idea. In 1810 a committee of the Institute reported, after trials of the Coessin boat, that "there is no longer any doubt that submarine navigation may be established very expeditiously and at very little cost."

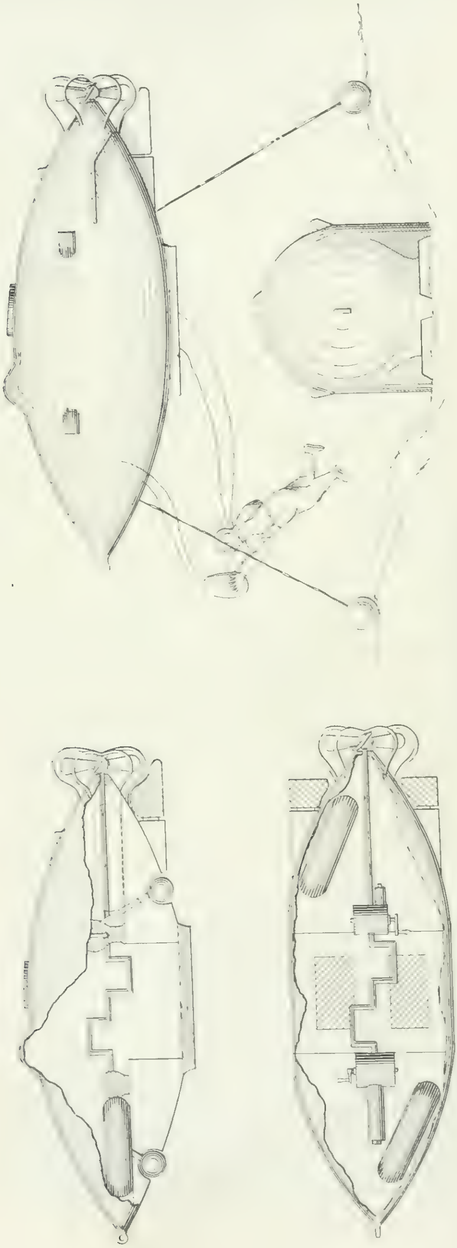
From 1810 to the time of the United States civil war submarine boats were designed every few years, nearly all of them driven by manual power and most of them following the ideas of Bushnell in forcing them down by an application of power apart from the diving rudder. During the civil war both the Federal and Confederate Governments tried to develop submarines, and failed of success only because the "state of the art" was not studied, and crude devices were tried. The U. S. boat was a failure in her propulsion—an absurd arrangement of duck-foot hand-worked paddles in an age when the screw propeller was in common use—and the Confederate boat, although she succeeded in sinking the "Housatonic," was a failure as a submarine boat and a death trap to her crews, because she was not worked as a submarine, but as a low-freeboard surface torpedo boat, for which purpose she was never designed and for which she proved dangerous and inefficient.

In 1863 the Brun boat, the "Plongeur," was built at Rochefort, France, and was one of the first to have mechanical motive power. In this case the power consisted of an 80 horse-power compressed-air engine. The boat herself was 146 feet long and about 12 feet in diameter—was, in fact, rather an ambitious attempt at a submarine boat. But the idea of *steering* a buoyant body under the surface had not arrived and she was made to sink by taking in water ballast until she was of the same specific gravity as water. In her first trials under Admiral Bourgois she had no diving rudders and was supposed to attain a desired depth solely by varying her weight. The natural consequence was that when she was made the same weight as water there was no control in the vertical plane. If she happened to be down by the head, her propulsion drove her down to the bottom, on which she carromed and bounced up and down between the bottom and the surface in her onward course. This defect was remedied later by fitting horizontal rudders, when she worked very well—with the usual result that she was declared useless by a Board, and made into a water tank.

The striking illustration of the need of horizontal rudders furnished by the "Plongeur" was little heeded abroad, and even in France the importance of the fact demonstrated was not grasped because the boat was at first designed to move in the vertical plane by varying her weight. One of the most curious circumstances connected with the development of submarine navigation is that in very few cases does

THE "ARGONAUT," ON THE SURFACE.

one find evidences of the study of the state of the art. The idea of attempting to move in water in three dimensions instead of in the usual two seems to have appealed to almost every submarine inventor as something so mysterious that no one could ever before have thought it out, and therefore almost all of them began *de novo,* with the consequence that our late patent files show designs for attaining results that had been reached a couple of centuries ago.



THE "INTELLIGENT WHALE."

During the last forty years attempts to solve the problem of submarine navigation have been almost constant and the progress has been generally forward, although often indirect and sometimes retrograde, and these years may be considered the era of the power-driven boats. One of the last hand-worked submarine craft was the "Intelligent Whale," which attracted much attention because she was bought by our government and became a United States vessel, although she possessed no feature superior to Fulton's design a half century earlier, and in many principles of design was inferior. She is remarkable only as an example of the power of conservatism which practically prevented her use for studying the laws of immersed bodies, which, on the one occasion she was operated after she became United States property, was responsible for manning her with an incompetent crew and trying her under ridiculous conditions, which worked up a great fright about the danger connected with her, and which led to the insistence that she should be hoisted out of water and be never again used. Within a few weeks there has appeared a press account of the loss of life in the "Intelligent Whale" with a total of forty-nine victims to her credit. As a matter of fact, no life has been lost in her or in any way connected with her, from the time she was built in Galveston, just after the close of the civil war, to the present day.

THE INTERIOR OF THE "ARGONAUT."

In 1877, Jno. P. Holland, of Paterson, N. J., built an experimental submarine boat in New York and made experiments with her on the Passaic at Paterson. She was the first submarine since Bushnell's time employing water ballast and always retaining buoyancy, in which provision was made to insure a fixed centre of gravity and a fixed absolute weight. Moreover, she was the first buoyant submarine to be steered down and up inclines in the vertical plane by horizontal-rudder action as she was pushed forward by her motor, instead of being pushed up and down by vertically-acting mechanism. Her petroleum engine, provided for motive power and for charging her compressed-air flasks, was inefficient and the boat therefore failed as a practical craft; but in her were demonstrated all the chief principles of successful brain-directed submarine navigation. In 1881, Holland turned out a larger and better boat in which he led the world far and away in the solution of submarine problems, and for a couple of years demonstrated that he could perfectly control his craft in the vertical plane. Eventually, through financial complications, she was taken to New Haven, where she now is. Meantime Whitehead had grasped all the principles necessary for automatic submarine navigation, had received encouragement instead of obstruction, and had brought his boats—automobile torpedoes—to a high state of perfection. Indeed, they leaped to so high a pinnacle of popularity that the designs of men-of-war of the last decade were hampered and loaded down with inefficient torpedo installations.

Since 1880 submarine boats have been experimented with in nearly all European countries, and in France, Spain, and Italy the governments have encouraged the experiments. In France alone has there been government encouragement through a series of years; and although the development in that country has been intermittent as a favorable or unfavorable administration came into power, the progress has been so great as to call forth official estimates and requests for the building of a submarine flotilla of 38 boats. The French type developed by the trials with an electric-storage motor boat, the "Zedé," is a very good one, deficient to be sure in some very important details, but sufficiently good for the economical and methodical French to be impressed with the great economy that submarines will bring to their mobile coast defenses.

While Mr. Whitney was Secretary of the Navy he was anxious to

THE SUBMARINE "GUSTAV ZEDÉ."

LAKE'S SUBMARINE BOAT, THE "ARGONAUT."

She is a "bottom worker," propelling herself by the wheels seen in the picture as well as by the screw. She has been particularly developed for commercial uses—wrecking, diving, and submarine construction—and is said to have traveled more than 1,000 miles under water along the United States coasts.

provide some kind of protection against gun fire for torpedo boats. and under suggestion he invited proposals for submarine boats. Several designs were offered and two propositions to build were made by the Cramps, the designs being those of Holland and Nordenfelt, the latter of whom had built five or more boats and had sold two to Greece and two to Turkey. The designs were most interesting for comparison, since they differed radically in the very important principle of control in the vertical plane.

Nordenfelt asserted that, in operating a boat under water, it was essential to keep her always on an even keel, and for this purpose he provided horizontal rudders, not for inclining her down and up, but placed in both bow and stern for the purpose of maintaining parallelism of the keel with the surface of the water. For submergence, he used vertically-acting propellers outside the hull in the plane of the midships section, and consequently the stored power was used to pull the boat vertically down against the resistance of her whole greatest longitudinal section and that of her reserve or normal buoyancy. As great longitudinal metacentric height as possible was given in the design. In short, the boat was to be as stiff as possible as regards any inclination of the keel in the vertical plane.

The Holland design was diametrically opposite as regards submerged manœuvering. It provided for small longitudinal metacentric height, for stern horizontal rudder only, was to give as lively a movement as possible in the vertical plane by the action of the stern rudder alone, and was to attain submergence and rising by pushing the boat by her whole motive power down or up an incline, the angle of which was to be determined by the angle of the horizontal rudder. The Nordenfelt was a down-haul or sinking design, the Holland a *steering* under, or diving device. A dogma was issued by Mr. Nordenfelt to the effect that the keel must always be kept parallel to the surface of the water, and this dogma was accepted by many naval officers because it was given out authoritatively, although it was never supported by theory, reasoning, or facts. The idea of rigidity in the vertical plane may have arisen from the fact that if the fixedness of the centre of gravity of a submarine boat be neglected she will be very likely to stand on her bow and rest on her stern upon occasion, as one of the

THE HOLLAND BOAT RUNNING AWASH, BEFORE THE FIRST DIVE.

Nordenfelt boats is reported to have done in the Bosphorus, and the fact that Mr. Nordenfelt's patents on submarines covered down-haul devices and nothing else of importance may have had some weight in increasing the rigid-keel cult. Now it is apparent that the livelier a surface vessel is on her helm the more satisfactorily can she be navigated in a narrow channel, especially when there must be frequent close approaches to either shore, and that under such conditions a vessel with slow turning power would be very awkward.

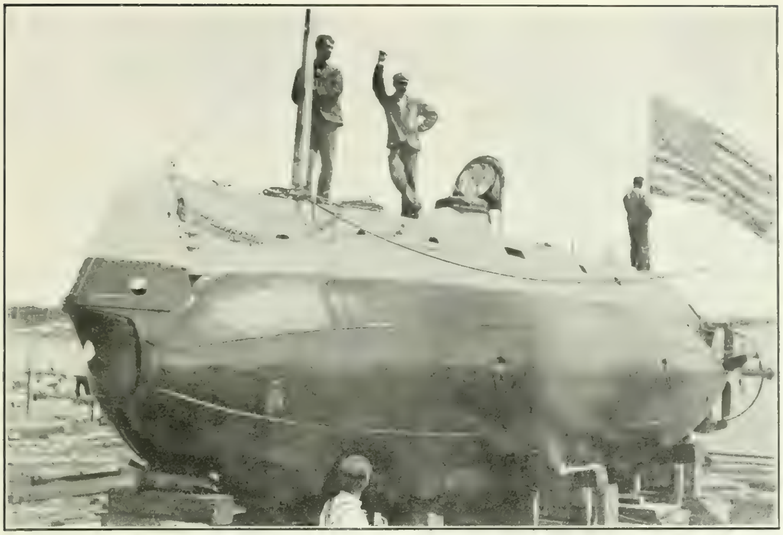
MAKING THE FIRST DIVE ON THE HOLLAND.

Submarine work for a torpedo boat is, in the vertical plane, confined to the very narrow channel, so to speak, between the surface and the seven-fathom mark, both of which must be frequently touched in coming up to see the position of the enemy and in going down to avoid gun fire and torpedoes. Both designs proposed steam as the motive power, to be used from a fired boiler while the boat was running on the surface, and from the same boiler with fires hauled as a steam store, or from a chemical heater, when running submerged, and both provided for retained buoyancy.

The Holland design was accepted because it embodied the ideas of a fixed centre of gravity, of an exact compensation for expended weights, of a low longitudinal metacentric height, and of quick diving and rising by the effort of the propeller pushing the vessel against the resistance of her midship section only, down or up inclines, the angles of which were to be determined by horizontal-rudder action. But difficulties in regard to guaranties of performance prevented the closing of a contract that year—1888—and the next year, after all preliminaries were arranged, a change in administration caused the matter to be put aside.

COMING UP FOR OBSERVATION.

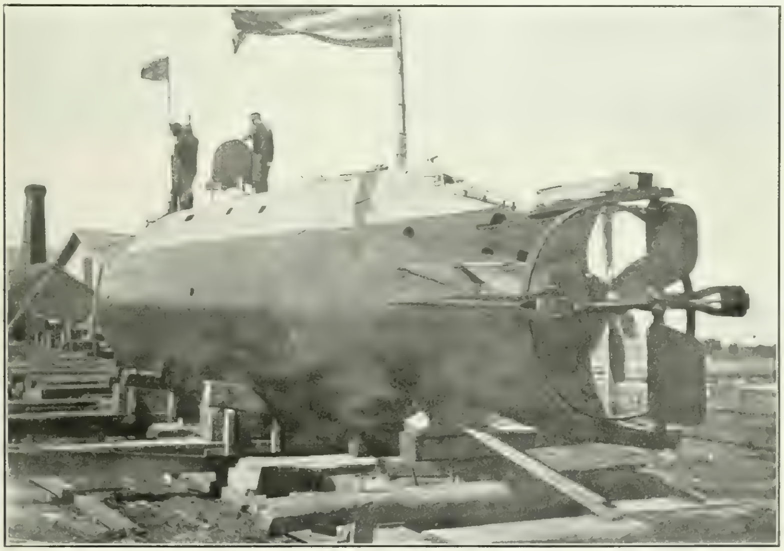
Just before proposals were invited by the Navy Department the Tuck boat was built in New York. Her salient features were the form of her hull, which was that of a narrow-beamed surface craft with a turtle-back deck, and numerous vertical and horizontal fins. This form and the fins were designed to prevent rolling, which was said to be very great in a submarine of the usual spindle-of-revolution shape because of the circular section. The facts that there is nothing



THE HOLLAND SUBMARINE TORPEDO BOAT. BOW VIEW.

to make a vessel roll when submerged, and that submarines practically do not roll at all when following wave slopes, were lost sight of.

After the second proposals of Holland were put aside, the Baker boat was experimented with on one of the Great Lakes. Her salient features were adjustable-bucket side wheels, placed with their hubs in



STERN VIEW OF THE HOLLAND BOAT.

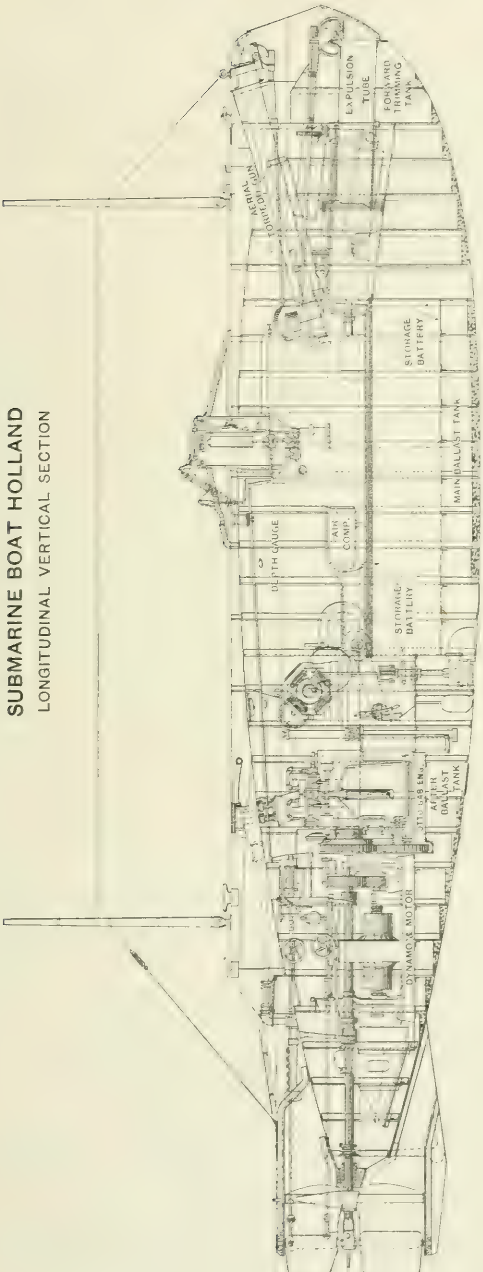
the midship section and adapted for directing the pull of the motive power in any desired direction and thus obviating the use of rudders. This device was found to be impracticable, for the same reason that it has proved so in surface craft—great waste of power.

On March 3rd, 1893, Congress authorized the building of a submarine boat, and after a third competition of designs and other delays a contract for a Holland boat was signed two years later. Details of the design were, by the contract, made subject to the Department's approval, and Mr. Holland claimed that some of these details as required interfered with the efficiency of the boat. This boat, the "Plunger," is not finished, the construction having dragged for many reasons. She is now undergoing a change in her surface motive power from steam to gas.

RUNNING ON THE SURFACE.

Meantime the Holland Company built a boat on their own designs, the "Holland," and she, last November, was reported by the Board ordered to observe her functioning, as fulfilling the requirements that had been suggested by the Department.

In the foregoing résumé of the development of submarines, I have attempted only to touch on such salient points as seemed to be illustrative, and have not attempted to record all the numerous endeavors to solve the problem of submarine navigation. In passing I would say that this development has already progressed far enough to produce two distinct types of practical under-water boats—the submarine torpedo boats like the "Holland" and the French boats, and the bottom



SUBMARINE BOAT HOLLAND
LONGITUDINAL VERTICAL SECTION

A NEW DESIGN FOR THE HOLLAND SUBMARINE TORPEDO BOAT

workers like the Travailleur Sous-Marin in France and the "Lake" boat "Argonaut" in the United States. Both these craft are intended for work along the bottom and both are arranged for use as a base from which divers in armor may work. The "Lake" boat gives good promise of efficiency. She is propelled along the bottom on wheels, after relinquishing all buoyancy while retaining her capability (by varying the amount of water ballast) of making herself weigh more or less according to the kind of bottom she passes over, and of making herself buoyant so as to rise over obstructions impassable for her ground wheels. At present she is not a true submarine in that she retains communication with the air by means of a tube. A boat of her type fitted with a true submarine motor might be very valuable for the attack of a mine field.

Turning to the type of submarine torpedo boat, we find that many of the desiderata for such a craft are found to be impossible according to the showing made in the "Holland," which is undoubtedly the most advanced example. For instance, it is desirable to get speed as great as that of the fastest torpedo boat; to have very great radius of action; to have a means of directing the course by vision upon a moving object while remaining invisible beneath the surface; to have the vessel very habitable and comfortable for great lengths of time; to have unlimited quantities of air for power and for respiration by the crew. These are not attainable at present, and there is no prospect that they will be until some entirely new and most efficient way of acquiring power be discovered and until some startling discoveries in chemistry be made.

As the development seems to have reached very nearly to the limit attainable at present, it is only necessary to assign comparative values to the tactical elements established by the "Holland" in order to reach a conclusion as to the utility of the type. These elements are:

Theoretical radius of action on the surface by means of the gas motor, 1,500 miles. Satisfactory for a small craft, and probably as exact as the radii given for the men-of-war of the world.

Surface speed 10 knots. Unsatisfactory; but since greater speed cannot be gotten without increasing length and thereby decreasing perfection of control in the vertical plane, it is acceptable. It is also acceptable because the surface running is only made when proceeding to a field of action and when out of the zone of practicable gun-fire.

Submerged speed 7 knots for 50-miles radius of action; 10 knots or more at the expense of radius. Unsatisfactory, but sufficient to be formidable when operating from inshore against ships outside.

Control and direction in the vertical plane. Perfectly satisfactory, since the boat can be held within a very few inches of any desired depth while running, and can be brought to the surface and again taken under with exposure of the turret-top for only a few seconds.

Control and direction in the horizontal plane. Perfectly satisfactory when running on the surface, since the boat is then under conditions similar to those of any handy surface boat. Unsatisfactory when submerged, since the object to be steered for cannot be seen. Acceptable, because any predetermined direction can be held as well as can any vessel's course in a fog or in a dark night and in the same way, *i. e.,* per compass; also acceptable because the quick rises and dives enable the helmsman readily to correct his course to intercept an off-shore enemy endeavoring to close with the shore.

Ventilation. Perfectly satisfactory, since the necessity of keeping atmospheric pressure in the boat necessitates ventilation, and since the compressed-air supply is ample for days when not used for mechanical purposes.

Field of vision when submerged. Nil, and therefore unsatisfactory as such; but acceptable because field of vision would carry with it the loss of the perfect invisibility which so largely adds to her effectiveness in attack, and because the quick rises and dives give perfect field of vision for a few seconds with a minimum of chance of disablement from gun-fire.

Habitability. Unsatisfactory on account of the cramped spaces. Acceptable, because she is sufficiently habitable to be endured for a few days at a time while lying off on picket duty, and because her crew can always be dry and warm and not suffer from heat as do the fire-room force of most naval craft.

Armament. Satisfactory, since it consists of torpedoes that can, from the conditions of fire, be delivered with accuracy fully as great as, if not greater, than can the same weapon from other types of craft.

Protection. Perfect, since neither gun-fire nor torpedoes can reach her when approaching to the attack submerged, and since the chance of her suffering from gun-fire when raising her turret a few inches above the surface for a few seconds is reduced to a minimum.

Sea-going qualities. Perfect, since no sea, however heavy, can affect her when in the awash condition ready to dive, and when running light she can always be dropped to the awash condition in heavy weather.

Surface motive power. Satisfactory, since it is the same that gives satisfaction in thousands of small surface craft using gas engines.

Submerged motive power. Unsatisfactory, since its source is the heavy and cumbersome storage battery. Acceptable, since it is the most available motive power for use when air cannot be freely used, and since the supply can always be renewed (when there is communication with the air by coming to the surface or by sending up a hose when the boat is lying on the bottom), through the use of the gas motor as long as the fuel supply holds out.

To my mind, the algebraic sum of the positive and negative efficiencies of the salient and determining features of the "Holland" type of submarines, in its present development, is a large positive quantity, and there seems to be no way of largely increasing it for some years. The capability of the craft for performing certain well-defined duties seems to be as well fixed by official trials as are the capabilities of other types of vessels by their trials, and the question arises, are these duties important?

From the report of the Endicott Board, from the oft-expressed opinions of Naval Officers, from the well-known condition of our coast defenses, fixed and mobile, even from a glance at the map of the United States in a primary geography—it is clear to the simplest mind capable of considering the subject that any enterprising enemy with whom we might engage in war would harass our coasts for the purpose of drawing our fleet into local coast-defense work and thus crippling its true war-stopping or war-waging power, by preventing the offensive work in which alone can its full power be utilized. It is apparent that coast defenses and fixed mines can do no more than prevent entrance to our ports; that surface torpedo boats, though very valuable, cannot meet battle-ships in day light; that coast-defense ships are either too expensive, if efficient, to be provided for the protection of all the points to be protected, or too inefficient if inexpensive.

The securing of our coasts so that our fleet may be free to do its legitimate offensive work is most assuredly a most important duty.

Can submarines do it? I have never heard a naval man of any nationality express the opinion that any battleship in the world could prevent, by her gun-fire or otherwise, the approach of a submarine of the efficiency of the "Holland," although many who have not seen her are quite positive that she cannot do what she does do, and has been reported as doing by a most careful Board of officers.

A sharp look-out would reveal the approach of a submarine in the day time and she might be picked up by search lights at night, as she rose to correct her course, although the chance of this would be very small, since she could readily avoid the search-light "lanes" arranged for defense against surface torpedo boats. When revealed she could be avoided by retreat, since her lack of speed would not enable her to chase a fast ship with any chance of success. Torpedo destroyers and other small craft thrown out in advance of the heavy ships could not stop her, since she could avoid them by diving and could continue to hold her course for the ships. If she were allowed to approach within good torpedo range her chance of delivering a torpedo that would put any ship out of the fight is exceedingly good; while the chance that a lucky shot from the enemy would destroy her as she rose and before her torpedo was sent, is extremely small.

Considering the hypothetical case of a single submarine defending a single point against a single ship, it is clear, if I am right as to conditions of present development, that the boat could force the ship away from the point of attack to a distance limited only by the fact that the boat must never be so far away from the point to be defended as to allow the ship time to do damage in case the latter took the chance of doubling back to the attack after she had been chased off. With a group of boats in the defensive, some of the former would of course be held on the inshore lines to prevent such doubling back.

If a distance limit of effective work well within the capabilities of present development be arbitrarily fixed upon, and if the effect of submarines within this zone be considered, we may determine their availability for securing the coasts and thus freeing the fleet.

Let us assume twenty miles as this limit—one seventy-fifth of her theoretical radius of action and therefore that part of her possible limit. If the existence of submarines in the defense forced a blockading line of ships from the five-mile limit at which shore works might be expected to hold it, off to twenty miles, it is clear that the area to be guarded by the blockaders would increase sixteen fold and at least four times as many ships would be required to hold the line.

After carefully considering all the conditions, and after ruthlessly cutting down the efficiency shown on official trials, I cannot conceive why the answer to the question should not be: "Submarines can secure our coasts more perfectly than they can be secured in any other way at present practicable."

Providing coast defense ships enough for the purpose, one hundred and fifty or two hundred, for example, in excess of the ships of our seagoing fleet, would to my mind be impracticable on account of the great expense in time and the enormous expense in money.

The provision of a number of submarines would give a proportionate amount of coast security, since their presence would result either in the absence of hostile ships or in the giving to us a chance to oppose our small boat with its small crew to a large ship with a large crew, with the chances of war in favor of the boat.

As a designer of ships, the economy in leading other nations in the adoption of submarines appeals to me strongly. For experience shows that as soon as any particular kind of fighting craft appears in numbers sufficiently large to make the effect of that kind felt, it forces great modifications upon existing types. Whether devices be invented whereby battle ships can meet submarines, or whether they will continue to be vulnerable to offshore attacks as now, certain it is that the general appearance of submarines will force important modifications in design, and certain it is that the first country to accept the modifications will enjoy great comparative advantage in saving in her naval budget.

COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

I.—THE CLASSIFICATION OF SHOP ORDERS.

By Hugo Diemer.

A MATTER of constant occurrence in manufacturing is that orders for machines are taken under condition that delivery shall be made within a certain time. Often this necessitates the rushing of work through the shops and the completion of machines which have been started on a stock order, or on some other order the delivery of which is not of so great importance.

If, as is frequently the case, a new order is issued for the completion of the work which has already been begun under a different order number, it will be seen that perplexing complications are introduced into cost figuring. I have seen orders worded as follows: "Complete immediately one of the machines begun on Order No. ——, and replace same." A cost clerk or cost department has, as a rule, sufficient troubles to contend with, without the infliction of needless complications like this. One of the best ways of overcoming this particular difficulty is the separation of all shipping orders as an entirely distinct series from shop orders. The clerk who enters shipping orders enters them simply in the consecutive order of their receipt, and it is not his business to determine from what shop order the goods are to be taken, or upon what shop order they are to be built.

Successful management is like the designing of highly efficient tools. It is based primarily upon the study of the best-known models and the adaptation of the best methods. Mr. Diemer writes as a practical man for practical men—clearly, definitely and concretely. His articles are essentially "working plans"—available for immediate use in the shop. They have stood the test of actual trial—have been "built from," so to speak. They are presented not as arguments, but as descriptions. All examples are drawn from shops whose splendid commercial success stamps the hallmark and guarantee of value on their methods. The order follows the natural course of work through the shops, and the whole scheme is thoroughly adapted to small and moderate-sized works as well as to large ones. It is practical, workable, usable discussion and exposition.

The following articles will be included in the series, which begins in this issue of THE ENGINEERING MAGAZINE:

I. The Classification of Shop Orders.
II. The Production Department: Bills of Material.
III. The Production Department: Store-Room Management.
IV. The Production Department: The Execution of the Work.
V. Practical and Accurate Time-Keeping.
VI. The Figuring of Total Costs.

When it becomes necessary to apply a machine from a stock order to some immediate-delivery job, it will be found most satisfactory to complete it under the order number under which it was begun, irrespective of the shipping-order number. In such cases a system of numbered memoranda or notes will be found to be of much value. For instance, the superintendent or head of production department writes a memorandum on a printed form with headings as suggested below:

> Instructions to Foremen No...........
>
> Shipping Order No............
>
> Shop Order No............
>
> *Please note that it will be necessary to complete for shipment within ten days one of the machines on Order No...... calling for 10 machines Type N 27 for stock. The shipping order on which this machine is to be applied is No......*

As many copies of the above instruction sheet are made as may be necessary to give one to every department concerned and in addition preserve office copies for proper filing. In case it becomes necessary to stir up any particular department again, all that is necessary is to refer to the above instruction by number. This method insures the completion of every machine under the order number on which it was begun, which is absolutely essential for the accurate determination of costs of manufacture.

Suppose, now, that from a stock order calling for ten machines, four have been rushed through and applied to hurry orders. It still remains true that it will be very advantageous to have sufficient new castings made for ten machines of a kind to be run through all processes at once. The head of the production department now writes a note as follows:

> Instructions to Foremen No...........
>
> Shipping Order No ....
>
> Shop Order No............
>
> *Please make the above shop order read 14 machines instead of 10.*

Where specific reference to shipping orders is not essential, the shop-order number only is filled in.

It will follow, of course, that of the fourteen machines built, the four which were rushed through will have cost more in proportion than the ten which have been put through all processes together, so that our cost will not give us the lowest price for which it is possible to build ten or fourteen machines; but it does give us the cost of the fourteen built under conditions which are bound to be more or less prevalent. To have issued a new order for completion of the four which had been already begun would have deprived us of the possibility of obtaining any cost figures at all.

I believe the most satisfactory system of orders is one in which, besides the entry of all orders consecutively as shipping orders, irrespective of what they call for, we subdivide the shop orders into separate classes or series. This subdivision should be done by a person thoroughly familiar with shop management. Thus we may have: "A," orders for complete machines which have to be built to order; "B," orders for repair parts which have to be built; "C," orders for any apparatus which can be shipped immediately out of stock, etc. There will be shop orders also for articles and operations which are not covered by shipping orders, such as orders for tools and running expenses. It is always desirable to know the cost of tools and machinery individually; hence it is bad practice to lump labor and material for all tools and machinery into standing shop orders which are closed monthly.

It will usually be found most satisfactory to have a separate series of orders for special tools which are made in the shop. Orders for tools may be designated, for instance, as "Order E." Besides special tools, such as jigs, dies, etc., there will be many small tools which are constantly wearing out. These can be made in quantity under orders in an "F" series. Small parts of machines which it is advantageous to make in quantity and to turn into the stock room will constitute a further series, "G." It must be borne in mind that such articles, placed in the stock room, must be considered exactly as material purchased, and proper credit given to labor accounts when their total cost is charged to "material"; otherwise they may be charged when completed in quantity and again charged when drawn singly from the stock room—an error which I have known to occur. We will next have an "H" series for drawings for standard machines, and an "I" series for patterns for standard machines.

Drawings, patterns, and tools that are likely to be special—that is, such as are used in the manufacture of special machines—should be put through under the order number of the particular job for which they are intended, so that the cost of the special job will include the cost of special drawings, patterns, and tools. It should be the duty of some one particular person to determine just which drawings, patterns, and tools are to be considered standard. Usually the head of the draughting department is thoroughly competent to determine this question, and he is particularly fit to do so because naturally all operations begin in the drawing room. It will be found desirable for the drawing room to have a book or card index in which a record of drawings and patterns is kept, headed somewhat after the manner indicated in the form given below:

Drawing No.	Pattern No.	Article.	Shop Order.
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

In a certain case where the above form was used, it was found advantageous to keep two sets of records, one for the drawing room and one for the pattern shop. The pattern-shop form was identical with that for the drawing room, with the exception that the first column was headed "Pattern No.," thus:

Pattern No.	Drawing No.	Article.	Shop Order.
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

By means of these records, the history of a pattern or drawing may be obtained at once by looking up the shop order opposite the number of the pattern or drawing. It is not generally feasible to have pattern numbers identical with drawing numbers, since there will always be a great many more drawings than patterns.

Having prepared a complete set or series of shop orders to cover all articles for which it is necessary to have specific orders, there will still remain about the shop a certain amount of work in the way of maintenance and repairs, and certain material will have to be drawn from the stock room which cannot be charged to any specific shop order. The system of "Standing Shop Orders" is intended to cover this class of labor and material. The foreman of each department has a sheet of the following form:

SECTION............

MATERIAL DRAWN ON STANDING SHOP ORDER DURING THE MONTH OF ....

Date	S. O. Order No.	Material	Quantity called for	Quantity delivered	Weight	Cost
....	....	....	....	....	....	
.....	....	....	....	....	....	
.....	....	....	....	....	.. ..	
......	....	....	....	.. ..	....	

He presents this sheet at the stock room for any material needed for use on standing shop orders. The stock room enters the quantity delivered and the weight. As soon as a sheet is filled, it is at once sent to the cost department. On the last day of each month all sheets are collected and new ones issued.

The list of standing orders will, of course, vary widely, depending upon the conditions in any particular shop. Merely for the purpose of illustration, a few items which would properly be included on the sheet are given below. The list of standing orders, fashioned somewhat like the pattern given herewith, is duplicated by the carbon or mimeograph process as many times as may be necessary to furnish every person concerned with a copy.

STANDING ORDERS.

S. O. No. 1.—Time of engineers and firemen. Labor and material for repairs and maintenance of power and lighting plant, including lamp renewals, arc carbons, etc. (Expense.)

S. O. No. 2.—Time of drivers and stablemen. Feed, labor, and material involved in maintenance of horses and wagons. (Expense.)

S. O. No. 3.—Labor and material for maintenance of yards and grounds. (Expense.)

S. O. No. 4.—Labor and material for maintenance and repair of buildings; time of janitors. Matches, soap, etc. (Expense.)

S. O. No. 5.—Repairs of machinery and shafting, repairs and renewals of belts. (Repairs Machinery.)

S. O. N. 6.—Repairs of jigs, dies, etc. Also new small tools, such as files; emery cloth, crocus cloth, etc. (Repairs Tools).

S. O. No. 7.—Repairs of patterns. (Patterns and Drawings.)

....

and so on.

If more standing orders need to be added at any time, care should be taken under no circumstances to change the numbers of any older standing orders with which the personnel of the factory have already become familiar by number. Modifications of already established standing orders may at times be advisable, but the importance of adhering to the same numbers for the same general purpose is self evident.

Material which enters directly into manufactured products, such as material used in painting, varnishing, and shellacking, should be provided for in bills of material, although it may be necessary for the foreman of the paint department to estimate the particular quantity used on each order. Paint brushes and varnish brushes may be charged to a standing-order number.

The insertion of the account to which each order is chargeable is advantageous, because it helps to explain the reason for having a system of standing orders at all. Shop foremen take far more kindly to system, if they are treated as intelligent beings and are allowed to see for themselves why certain systems are necessary, than they do if they gain the impression that particular forms are thrust upon them simply because the management wishes to be arbitrary. This last impression is frequently produced by unnecessary reticence and secrecy where none is required by the circumstances. Be frank and open with your men and they will treat you likewise.

A careful classification of the particular items constituting the expense account under separate standing-order numbers will enable the management to compare them from month to month from the cost department's summary of these orders. Familiarity with the minutest details of the expense account is absolutely essential, for it enables the management to call attention to certain specific points instead of announcing the broad statement that "This expense account must be kept down." I know of a case where a superintendent, wearied by this constantly recurring announcement, gave instructions that all files, small tools—and, in fact, all labor and material generally that could be stowed away under customers' order numbers—should be so charged "in order to reduce the expense account." A conscientious manager, however, will not attempt to produce fictitious statistics, but will do all in his power to show existing conditions plainly as they really are.

THE FOLLIES OF SOME AMERICAN EXPORT TRADERS.

By an Export Salesman.

A SUBJECT which is attracting earnest attention in the United States at the present time is that of foreign trade, and the entry of American manufacturers as competitors in markets which they have only recently sought is exciting keen interest in England and on the Continent. A few glimpses of the matter as it appears when seen from the European buyers' viewpoint are timely, and it is with the assumption of this stand that the following observations are made.

The great question in foreign trade is: How can the buyer be reached in the best manner? This question may be met in a variety of ways, and my long observation leads me to answer it by showing "The Way Not to Do It," and adding thereto a few practical suggestions.

It is proper to state, at the outset, that products of the farm are entirely excluded from the subject here treated; the conditions governing the export of agricultural products, such as grain, hogs, and cotton, cannot be applied to the export of manufactured goods of any description whatsoever, for the simple reason that agricultural product is the product *par excellence* of the United States, and is one that the foreigner must have in order to sustain life; while the manufactured product, sold in competition with England, Germany, France, and Belgium, is sold to the foreigner, not because he cannot get along without it, but because in certain lines the American excels in the cheap and rapid production of the article sold, and in other cases because peculiar market conditions allow the American manufacturer to undersell his foreign rival.

There seem to be a large number of American manufacturers who think they want foreign business, but who want it only on the condi-

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The writer of this article— a salesman of ripe experience and proved ability—is particularly familiar with the Continental market for machinery, machine tools, and similar lines. His comments are addressed especially to American exporters, because his experience of their methods has been most extensive and vivid.

There are, of course, many American houses who are cultivating European trade with the utmost commercial enlightenment, tact, and adaptiveness; on the other hand, Anglo-Saxon intolerance of, or indifference to, the foreigner is by no means confined to the United tion that it will fall into their hands at the expense of a few cents in postage for a letter, usually badly-written, in a language (English) of which so many of their prospective customers are totally ignorant, or know so little as to make the reading of it a Herculean task. It is obvious that such letters—frequently mimeographed, and badly at that—are treated as all circulars usually are, namely, thrown away. It would be curious to note the effect of a circular of the same kind, written, say, in Hungarian, to one of these same American houses, offering goods to the recipient that he did not want and had no interest in; yet the same effect is produced in Europe by hundreds of such circulars received in the various trade centres every day.

"Circularising" Europe from America for business does not pay under any circumstances that have ever come under my notice; but circularising Europe *from some point in Europe*, for the same class of goods, can be made to pay, and pay handsomely. It is not to be expected that buyers will take up an article about which they know absolutely nothing but what they can learn from circulars and subsequent letters (admitting that the recipients of the circulars may write to the senders of the circulars), when they have the very thing, or practically the same thing, right under their hands all the time, for sale by their own people, speaking their own language, with every facility for immediate shipment and with sufficient stock in hand to enable deliveries to be made the day the order is placed.

The next catalogue of would-be exporters are those who calmly demand of a consul, as a divine right, that their name and address be handed to each and every buyer in their line in the district to which the consul may be accredited; this is such a blatant absurdity that comment is superfluous; yet I have under my hand at this moment such a letter, and I have seen others. I have had such letters handed to me by consular officers with the suggestion that the firms sending them be addressed in the hope of obtaining information or prices; eighty-five per cent. of such houses, doing probably a large and successful busi-

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States, and the Briton, as well as the American, may take warning by the "horrible example" depicted in the article and profit by the contrast afforded by the careful and painstaking German. To the manufacturers of the United States and to their commercial and industrial rivals, their increasing attention to export markets and their attitude toward the foreign buyer are alike matters of extreme interest.

True and dispassionate criticism is one of the rarest things, hardest to be come at by entreaty or purchase, but of most value when it can be had. Unfortunately, not everyone appreciates faithful correction by his friend, nor can dissociate criticism and the critic, who may therefore suffer in his person from the displeasure which should be directed against the fault he has pointed out. For this reason the writer of this article prefers that his name be not publicly used; but if any of our readers are so interested as to desire to follow the matter further, we are authorised to give his name and address to such applicants, and will take pleasure in giving prompt attention to their inquiries.—THE EDITORS.

ness in the United States, make the feeble effort just cited for foreign trade, and do not even reply to letters written them in response to one of their circulars; this has been the case in my experience over and over again.

It would be interesting to ascertain the value in dollars and cents accruing to the American manufacturer in general, and to the "commission houses" in particular, from the immense amount of work put upon American consular officers abroad in the preparation of the special reports published in book form every month by the State Department at Washington, and disseminated throughout the country for the benefit of American commerce.

Yet a lot of manufacturers of a special line of goods will induce the State Department to order its representatives abroad to study and make an exhaustive report, on the plea that business can be done. These very people, or people in the particular line of manufacture in question, upon being addressed for prices, etc., will either not reply at all, or else say: "Our experience goes to show that foreign business is so very unsatisfactory that we do not care to quote for export, being convinced that there is nothing in it." This useful information is sent abroad either with no stamp or with a two-cent one, the result being that the unfortunate foreigner has to pay from six to ten cents to receive the communication.

Still another class is the one that will gladly give all information, and wind up by intimating that cash in New York is a *sine qua non* to any business; and they give explicit directions about opening credits, etc. Many American manufacturers do not seem to realise the fact that there are as many people in Europe with financial honour as there are in America; and those merchants or manufacturers who make a practice of insisting on cash before shipment, especially for such articles as canned goods, fruits, and other like products, are generally wasting their time in their effort to create a market. It is a deep mystery to the average understanding why an American exporter should expect his foreign customers to trust him implicitly, while he places absolutely no reciprocal trust in his correspondent's honour or integrity. A glaring instance of this came under my personal notice a very short time ago; a house was addressed with the request that certain prices, etc., be forwarded for the consideration of a company who desired to buy about seventy thousand francs' worth of the particular line of goods in which the exporter was interested; the reply came back very promptly, and was to this effect: that the buyer in Europe should pick out from various catalogues the goods wanted (these catalogues to be found by the buyer, none being sent), submit the list to the exporter, and let him make the prices on the understanding that all the goods were to be paid for before being let out of the exporter's possession, the payments to be made in New York by means of credits to be opened. To make such a proposition as this to a company having a million and a quarter of francs—$250,000—in bank all the time, and a paid up cash capital of four times this amount, would have been followed by the immediate and effectual "firing" of the proposer from the offices of the company in question.

Before leaving this particular variety of exporter, there is still the one who says that cash against shipping documents is not necessary, but the acceptance of time drafts before the goods will be delivered is the only way in which business can be done. Exporters can figure out for themselves the effect such a proposition would have on the very largest and richest of their own American customers; in many lines in Europe, such as gas-plant supplies, water-works goods, and supplies for electric street roads, the cities themselves are the buyers, and these cities have the misfortune not to be ruled by any Tammany cliques—which means that no one has to be "seen" in order to get the business in sight; but hard as it is for a foreigner to get in, if the additional handicap is thrown on the seller of having to ask some one in the city government for such security as accepting a draft, such a course would make business impossible. The cities all have their regular pay days, and it is not possible to make them deviate one hair's breadth from their rules as to payments. The manufacturer on the spot is only too glad to accede to the terms of his buyers, be they cities, corporations, firms, or individuals; but he first takes care to do that which the exporter will not do, viz., satisfy himself as to the credit of the prospective customer before he begins to discuss or undertakes to dictate terms of payment.

The most remarkable thing is the indifference to foreign trade exhibited by American manufacturers, high and low, big and little, during busy seasons at home. A more short-sighted policy could not well be imagined than to tell the foreigner that there is no time to bother with him because of the press of domestic orders; yet this very statement was made to me when I humbly requested one of the largest of the new trusts for a price on over a hundred thousand dollars' worth of material, deliverable, so to speak, at the convenience of the manufacturer. The amount of damage that has been done in the past eighteen months to American manufactures from exactly such causes as the foregoing will be seen immediately business begins to fall off in

America, and the people who will reap the benefit of this policy will be America's great commercial rival, Germany. A German manufacturer is never too busy to get a new customer, and he always has the time to study the customer's wants and to supply him with what he wants, instead of making the never-ending excuse that some of the goods required are not "standard" and that he cannot undertake the business, except at exorbitant prices.

To sum up, then, as to the methods that will secure foreign business, the following is put forth with diffidence, and with the statement that the suggestions are not intended to be taken as perfect, as incapable of being changed to meet peculiar conditions, or as possessing originality. On the other hand, it is claimed that, if followed out, the suggestions will increase the foreign trade of the United States with Europe on manufactured goods.

This is the summary:

Write to your customer in his own language; or, if this be not possible, write in French to the Frenchman, Belgian, Italian, Russian, and Scandinavian, and in German to the German, Austrian, and Dutch. It is vastly better to write to every continental firm in French than to use English; they one and all would prefer a badly written French or German offer to a well written English one. The time will come when English will be universally spoken, but that time is far off yet.

Write letters; do not print them—that is, do not mimeograph and send forth broadcast thousands of letters which generally come to nothing in the shape of business.

Give full and concise answers to letters asking questions, and do not put your correspondents off with evasive replies, which, alas, is such a prevalent error.

Do not expect the American consular officers to transact your business for you; pay an agency similar to the Bradstreet and Dun companies to tell you who and what the people are with whom you wish to deal.

Go after the foreign business exactly as the home business was sought; that is, pay some intelligent man enough to make it an object to him to represent your goods in the best light; in other words, spend money to get the business in the same manner that money was spent to get the domestic trade.

Do not start out with the idea that all foreigners are *ipso facto* dishonest or unwilling to pay for goods they may order. Take the time and trouble to ascertain something about the financial responsibility of the house to whom you wish to sell goods, and then accord it the same treatment you accord to your domestic customers whom you know to be solvent.

Do not scorn foreign business because domestic trade is good; it is a well known fact that trade moves in cycles of prosperity and depression; in prosperous times like these merchants can well afford to spend money in order to "lay pipe" for foreign trade when the domestic depression comes.

Finally, ship exactly what you agree to ship, and at the time the goods have been promised; nothing is more exasperating to the foreign buyers than being continually put off with excuses for non-shipment of goods promised for a certain date, notwithstanding the cast-iron rule printed at the head of so many manufacturers' letter paper to the effect that they will not "be responsible for strikes, and other causes beyond our control." This is probably the most elastic clause that has ever been invented, as it can be made to mean anything and everything.

Promptness, accuracy, confidence, perseverance, and fair dealing are the five key words to the success of securing and holding foreign business by American manufacturers. Promptness in answering letters, accuracy in the filling of orders, confidence in the integrity and solvency of the foreign buyer, absolutely fair dealing in all transactions, great or small, and perseverance in everlastingly "sticking at it"—will bring a golden harvest to the American manufacturer in the European field. Without these five cardinal virtues, and unlimited patience, efforts will be futile, or the returns from such efforts will be very small and insignificant.

RUSSIA'S FIELD FOR ANGLO-SAXON ENTERPRISE IN ASIA.

By Alexander Hume Ford.

ASIA is destined to become the theatre of the greatest engineering feats of the coming decade — military or commercial — perhaps both. Russia, partly with Anglo-Saxon gold, is pushing railways into Turkey, Central Asia, Persia, Afghanistan, Siberia and China. Her great engineering problems are being overcome by Anglo-Saxon ingenuity. The steel bridges over the broad rivers, the locomotives traversing the vast steppes, the steel rails, the track-laying tools and labor-saving devices which have made possible Russia's phenomenally rapid railway advance into Asia in the last few years—all are ours, even to the air-brake system, with which all the Russian railways are being supplied. With orders amounting to $12,000,000 for material alone with which to complete the Chinese Eastern Railway, pouring into America and England, what future requirements we will be called upon to supply, when Russian railways reach Persian ports and the vast territory of Central Asia is opened up to our trade, can not even be conjectured.

The building of the Chinese Eastern Railway through Manchuria poured millions of Russian roubles into the pockets of American and English manufacturers of machinery and railway supplies, and has opened up a vast new territory in which will be expended much restless energy of the Anglo-Saxon race in the next ten years.

In the editorial pages of THE ENGINEERING MAGAZINE for May, comment was made upon the extent to which the United States were supplying the markets of Eastern Asia. Mr. Ford, who has recently returned from an extended tour through Manchuria and Eastern Siberia, as well as Japan and other longer-opened territory in the Far East, gives the testimony of an eye-witness. His graphic portrayal of the industrial situation and the meaning it has for England, America, and Continental Europe, is full of the keenest interest. It has the personal force of direct individual observation and report.—THE EDITORS.

Besides railway materials, bridges, and all kinds of machinery, every species of farming implement, from the humble plow to the mighty mower and reaper, must be imported from without; and it should not be forgotten that Anglo-Saxon material has driven all the Continental countries out of competition in Manchuria within a period of less than two years.

Russia, with her dozen or more railways rapidly penetrating into Asia at every conceivable point, is developing a continent containing one-half the population of the world. It will be many years before she can supply the mechanical needs of these people, to say nothing of the requirements of those who emigrate by the thousand into the newly opened territory. Although the Czar is calling upon Anglo-Saxon engineers to equip his railways with machine shops containing all known modern appliances, it will take some time for the mechanics of other nations to supply the equipment needed to enable Russian engineers to build their own locomotives. Machinery for factories of all kinds, flour mills, breweries, and electric light plants, is still pouring into Siberia and Russia from abroad.

THE FIRST AMERICAN LOCOMOTIVE ON THE CHINESE EASTERN RAILWAY.

Russia will not reap the first fruits of her railway invasion of

Asia. She is not the rival in the construction of her railways to be feared by the Anglo-Saxons. A new power has risen at the very doors of Asia. Forty million progressive, irrepressible Japanese stand ready, by force of arms, if necessary, to open the door of new Asia to their manufacturers. It is the only hope of salvation for the over-crowded Island Kingdom, and its people will fight for this last chance with desperation. Already Japan is beginning to undersell other nations in supplying material for the Siberian railway, and Russia will buy in the cheapest market.

Last July Japan entered the family of civilized nations, becoming by treaty everywhere open to foreigners. She will multiply her machine shops and factories, besides inviting capitalists of all other nations to enter Japan and erect plants where coolie labor is cheapest. Even now Japanese ships convey freight at almost a nominal tariff, and with the open-door policy enforced in Asia, Japan will doubtless be the greatest gainer. Already her merchant marine is driving other vessels out of the far eastern seas, and Russia holds her own on the water only by most stringent restrictions against Japanese vessels.

With the imminent possibility, if not likelihood, of an early war between Japan and Russia for commercial supremacy in China, with

A SHIP OF OLD JAPAN.

The style of vessel used by the company preceding the Nippon Yusen Kaisha.

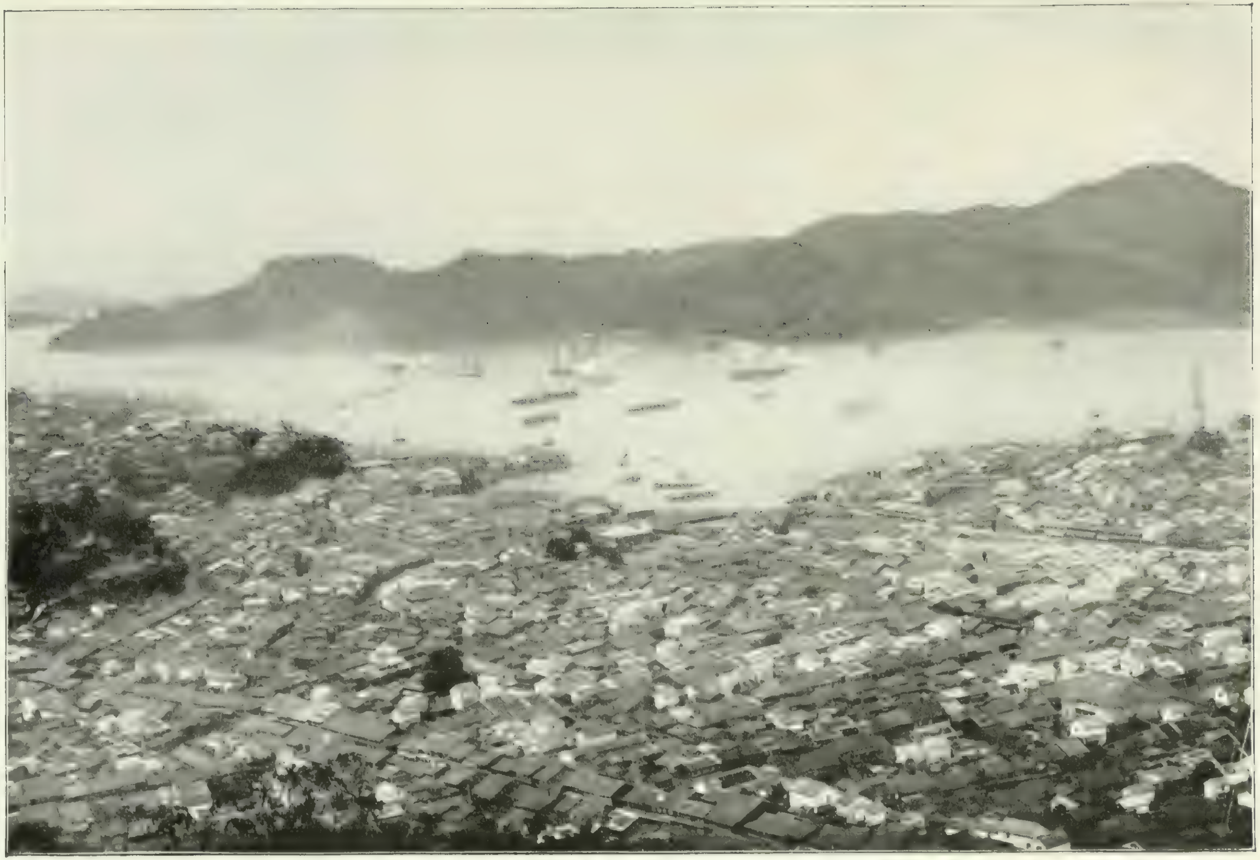
THE TATEGAMI DOCK AT NAGASAKI.
Where Japan builds her own modern warships.

England on the side of Japan and France on the side of Russia, a brief review of Japan's commercial rise to competition with the so-called civilized nations will go farther than anything else toward giving a clear insight into trade conditions and the future of Anglo-Saxon commerce in the Far East.

With Japan's awakening thirty years ago, England was called upon to build railroads everywhere in the Mikado's Kingdom. The Japanese, being natural born mechanics and engineers, soon learned the methods of the machine shop, and now Japan builds and equips her own railways and the English engineers have been relieved, so that a white-faced employee is never seen on a Japanese railway today. Foreigners no longer drill her army, Anglo-Saxons no longer man her ships. The native junk of thirty years ago has given place to magnificent ocean steamships which the Japanese have learned to build. England and America are still building war-ships for Japan, but at Nagasaki last summer I noticed the government was constructing at least a dozen torpedo boats, while in the immense dry-dock one of her largest war vessels was undergoing repairs. At the government ship yards war vessels are now built by the Japanese, and the days when such ships will be purchased from foreign constructors will soon be past. The same holds true of the merchant marine. One company, the Nippon Yusen Kaisha, which a few years since owned only a few sailing vessels, now possesses a magnificent fleet of ocean steamships, nearly one hundred in all, with lines to America, Australia, London, Hamburg, France, the Philippines, and India, to say nothing of the local branch lines to Chinese and Siberian ports. These boats, manned by Japanese crews even to the engineer, have played havoc with the freight and passenger rates not only in the east, but between America and Asia, as well as between Europe and China. They threaten to drive all competitors from the Pacific ocean, and there are those who believe Japan will yet become mistress of the seas, and displace England from her high place, commercially at least.

INAUGURATION OF THE NIPPON YUSEN KAISHA LINE OF STEAMSHIPS TO EUROPE.
President Kondo delivered an address at Kobe from the deck of the Tosa Maru, the pioneer steamer of the line, March, 1896.

England developed the engineering genius of the Japanese, and British firms led the way into Central Manchuria after Russia had once begun to develop that country. Commercial and national rivalry do not always work injuriously to each other, for shortly after England's naval demonstration protesting against the Russian occupation of Port Arthur, the Czar's government placed enormous orders in London for material to insure the rapid completion of a railway that would connect St. Petersburg with Port Arthur and throw Manchuria inevitably into the possession of Russia, and this development of northern Asia was brought about with a marvelous rapidity not equalled even by the settlement of some of the western United States.

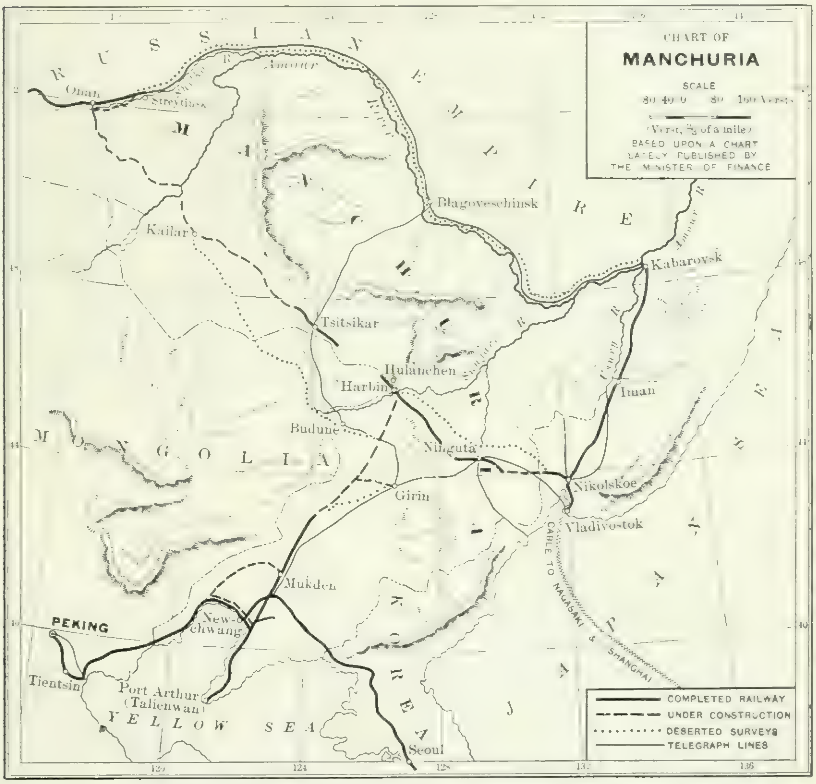


THE HARBOR OF NAGASAKI. MEN OF WAR AT ANCHOR.

Cities and towns sprang up in a night, and European Russia began pouring into Manchuria a steady stream of immigration which is still flowing into that country in greatly augmented volume. Steamships were chartered in England, and several lines between the Baltic and the Black Sea and Russia's new possessions in the Far East were put into operation.

It was necessary to build the railroads through Manchuria by the sole aid of vessels. From every quarter of the globe material and supplies come by water to Port Arthur, Vladivostok, and the Amour River. Orders were at once placed in England for fifteen steamers and forty steel barges to be sent in sections to Vladivostok. These were taken by rail some two hundred miles overland to the head waters of navigation of the Usuri River; here they were put together and loaded with rails, locomotives, and machinery, and began their two-thousand-mile journey down the Usuri to the Amour, up that noble stream to the Sungari River, and thereby into the centre of Manchuria. The last-named river is crossed by the Chinese Eastern Railway at three different points, hundreds of miles apart, and from its banks, in both directions, the railroad was begun at several points. Some of the steamers were employed to carry material and track-laying tools to Stretynsk at the head waters of the Amour, and here again, at the present termination of the Trans-Siberian Railway proper, track-laying toward St. Petersburg was begun.

It did not take the news of the opening of this great territory long to reach America. Soon the finest business house in Vladivostok was erected by an American, the most spacious Chinese structure in Port Arthur was secured as an agency, and the introduction of American tools and American locomotives was begun. American activity was abroad in the land, and while the Russian engineers at first laughed at the idea of American manufacturers competing with Europe, they were induced to give a few orders. To their astonishment the goods arrived in less than three months and proved the most durable and efficient tools up to that time imported into Manchuria. The Russian officials suddenly realized that just across the Pacific pond, not five thousand miles away, they could supply all the needs of the new railway, and all hurry orders were promptly cabled to America, whose markets were some fifteen thousand miles nearer Eastern Siberia than those of Europe. American engineers who could speak the Russian language fluently enough to converse in technical railway terms with the Russian officials of the railway found that a golden stream flowed through their hands to the manufacturers in America. Last summer the Chinese Eastern Railway went so far as to send over two of its engineers, as a committee, to visit and report on the outlook in the United States of procuring every kind of railway appliance. They reported that more than three-fourths of the material and equipment still needed for the completion of the Trans-Siberian Railroad, as well as the steel bridges, could be procured in America, of a better quality and more cheaply than in any European country.



Since then Russia's railway projects in the Far East have been greatly augmented, and recently cablegrams were sent over for material for a branch line on to Peking, so that now Russia is building with all speed from four Pacific Ocean ports (Tientsin (Peking), New Chwang, Port Arthur, and Vladivostok) toward her great Trans-Siberian system, and tons upon tons of machinery from the United States lie stacked upon the wharves of these cities, so adjacent to the western seaboard of the United States. Already the railroads

ON THE WHARF, VLADIVOSTOK.
Landing American rails from a steamer.

extend for many miles into the interior from these ports, and in fact, before spring navigation is opened, it is expected that they will all be connected with Harbin, on the Sungari River, which is the central point of meeting for the lines in Manchuria.

This city is not yet a year old, but it contains many thousands of inhabitants, spacious office buildings, splendid machine shops, asphalted pavements laid down by American steam rollers, and a Yankee electric-lighting plant. Harbin is also the winter quarters and general terminus for the line of English steamers and barges. All that remains to be built of the Chinese Eastern Railway is a partly completed section eastward from Harbin, through the mountains of Manchuria to China on the line of the Trans-Siberian Railway. It is the most difficult section of the entire Trans-Asiatic undertaking, but it is confidently expected that within another year it will be completed to such an extent that, by utilizing the frozen rivers in winter time, temporary tracks can be laid and through trains run from Peking to St. Petersburg.

Forests are being cleared, workshops established, towns and cities located, and drainage systems laid out, in anticipation of the coming population that will pour in from Russia when the new road is opened. Freight and passenger tariffs will be extremely low, intending settlers being able to travel third class from Moscow to Manchuria for about forty dollars or less. Already the advance guard is beginning to raise wonderful crops of wheat, and more than one completely equipped flour mill has found its way across the ocean to be erected in central Manchuria. Gold mines are being opened up, and the whole country seems to be on the verge of a boom which will doubtless soon bring about the consummation of the much talked of direct steamship line between the Pacific coast of North America and Russia's Far Eastern ports. As matters now stand all freight is trans-shipped at Nagasaki, and either the Japanese or Russian steamship lines transport it to the required destination. This, of course, entails an enormous expense, which practically puts England, although ten thousand miles further away from Siberia than the American Pacific coast, on an equal footing if she can send her goods direct to Vladivostok by tramp steamer; but even by this roundabout route,

THE VLADIVOSTOK WHARF.

Divers recovering rails which have fallen overboard during unloading.

New York is competing with London, for a regular freight line is now established between the former port and eastern Siberia.

Russia having forced the Government at Peking, after the seizure of Port Arthur, not only to grant extensive railway concessions in Manchuria but to assist in carrying out the building of the road, other European nations, and even American capitalists, beseiged Peking and demanded various concessions in every portion of China, and with such success that the Celestial Kingdom is to-day surveyed for a network of proposed trunk lines, some of which are under construction. The majority of these concessions are either Russian or English, and, with the exception, perhaps, of the comparatively insignificant German concession, doubtless Anglo-Saxon material will build all the railways now proposed in China. Not only that, but as the rich iron and coal beds are opened up in the interior, England and America will be called upon for the heavy machinery, and as factories are established the equipment must come from without. It will be some time, however, before China will take kindly to modern machinery. Foreign investors have discovered, after erecting expensive plants, that coolie labor at a penny a day is cheaper than steam power, and at Hankow the tea merchants have gone back to the hand-pressing process of packing brick tea, as more economical than burning coal to run the compressing plant.

The French in Burmah are using American material in the construction of some of their railways, and American rails and locomotives are beginning to find their way even into India. While England will not listen for a moment to the proposition that Russia shall extend her Central Asian line from Herat to the Persian Gulf, doubtless when it has become an accomplished fact there will be a lively rivalry between the manufacturers of the two Anglo-Saxon countries as to which shall supply the bulk of the material for the construction of the vast gridiron of steel with which Russia has planned to cover Turkey, Persia and the entire Trans-Caspian country. It should not be forgotten that Prince Hilkoff, who is at the head of the railway system of Russia, received his engineering education in the employ of American railroads, and is thoroughly conversant with the technical details of all the most recent railway and mechanical inventions and devices of the Anglo-Saxon. No English or American engineer need hope for actual employment in connection with these enterprises of Russia, but the great bridges will be built in America, and American engineers will design them. American manufacturers will send men into the new country to study the peculiar class of material and form of construction made necessary by the contour and climate of that part of the world, and, as the Russian government is contemplating spending additional millions on irrigation works, machinery for dredging canals, and later, machinery for sowing and gathering the great cotton crops, will be imported on a large scale.

A STREET SCENE IN VLADIVOSTOK.

The dummy line on the left was laid with the first American rails sent to Siberia.

What changes will be made in Russia's railway plans on account of the entrance of Germany into Turkey remain to be seen. While Russia has always regarded this as her future possession, England has successfully kept her from actual inheritance, and now that Germany is gridironing Turkey with steel rails it is quite likely the two countries will come to an understanding, for the building of Russian lines through Persia to connect with the Turko-German railway will enhance the value of both. Germany, of course, will build her own roads; but the development of Turkey will in many ways be turned to the profit of other nations

Russia still places as much dependence on her internal waterways, as means for the carriage of produce, as she does on her railways. Great ship canals are being built through the Empire, connecting the

Baltic with the Black Sea and the Arctic with the Caspian; again, it is hoped to connect the Caspian with the Sea of Aral, thus bringing all central Asia into easy water communication with St. Petersburg and all parts of European Russia. The lesson of the Chicago canal has not been lost on the Czar, and his representatives have carefully studied the mechanical development in canal building displayed in Illinois, for the canals of Russia also pass for the most part over great level steppes.

And so, hand in hand, railways with waterways, Russia goes on extending her empire, spending millions on these internal improvements instead of on foreign wars. The government guarantees the interest on the money invested, and indirectly, if not directly, reaps a rich reward in the enhanced value of the land traversed by the canal or railway. Especially is this so in the case of the Trans-Siberian railway. No land grants were given to private corporations, but hundreds of thousands of peasants poured over the Urals, land was leased from the government direct, and the great broad acres of Siberia were planted in wheat. The government encouraged modern methods, and again America and England were called upon for plows and reaping machinery. The new lands yielded marvelous crops, so that for hundreds of miles it has been necessary to parallel the Siberian railroad by another, some miles further north, and even then it has been found that the single-track system is inadequate to transport the enormous crops of wheat, so that thousands of tons of grain are left at the various stations to rot in the open air, while people in central Russia are dying of famine. And now the great rivers of Siberia are to be used to export grain and coal, and to import machinery. The Trans-Siberian railway has been extended across northern Russia to Archangel on the Arctic Ocean; from this point ships can sail in summer to the mouth of the great Siberian rivers, the Yenisei being navigable to within a few miles of Lake Baikal. Efforts are now being made to dredge the separating barrier, when the waterways of Mongolia will be opened up to direct internal water communication with Russia proper. Anglo-Saxon influence is largely responsible for the great awakening in Siberia.

The men who read Spencer and Ruskin were transported by thousands to Siberia; after serving their terms in prison, they were compelled to settle in Siberian towns; their influence was felt, so that today Siberia is by far the freest portion of the Russian empire, and many of the Czar's people emigrate there to enjoy the larger liberties allowed. Cities have sprung up, peopled mostly by the political exiles, all men of advanced ideas. Many of those stationed near Vladivostok have escaped in sailing vessels and found their way to America, and after learning the English language have returned to Siberia in the capacity of business agents for American houses. The officials have winked at the return of the exiles, and to-day there is a kindly feeling towards Americans from one end of Siberia to the other. The recent influx of American machinery has not been met with any animosity, but, on the contrary, the Siberian engineers constantly urge the officials at St. Petersburg to allow them even more latitude in ordering building material from across the great Pacific pond.

The prospects for the next decade point to a demand in Asia for the greatest engineering contrivances and equipment ever known in the history of the world. France, Belgium, Germany, England, America, and Japan will contest for the privilege of supplying most of this material. Already America has placed her first entering wedges. In Korea the electric railway in the capital city is an American enterprise, the mines are being exploited by American engineers, and new concessions are being frequently asked for by American citizens. Russia and Japan both look on with envious eyes, and Japan is pushing her railway

THE HOTEL AT VLADIVOSTOK.

on to Seoul, with the hopes of soon monopolizing the Hermit Kingdom and incorporating it in her own domains—in which case, of course, Japan will make her own improvements with as little outside aid as she can get on with. And as Russia is also pushing her railway toward Korea, this little country is likely to be the scene of the next Asiatic war.

England, who is friendly to the United States, practically controls all of China south of the Yang-tse-Kiang, and India; and all west of this remains for the present an open question, with the chances of Russia solving it in her favor. But that several Trans-Asian railway lines will connect Paris and London with the Pacific Ocean, within the coming decade, there remains no doubt; and, besides these, there are the lateral lines which will necessarily be built.

NEW JAPAN. A STREET SCENE IN KIOTO.

The trolley cars are of American manufacture.

A whole new continent is being educated up to civilized wants. Asia, from now on, becomes the engineer's paradise, and it remains to be seen whether Anglo-Saxon push will continue to control and supply this great field, or give way before the wily Slav, or the agile, hardy Jap. Doubtless there will be work enough for all, once the coming development is well under way.

NEW SHOP METHODS A COROLLARY OF MODERN MACHINERY.

An Editorial Comment.

IT is clear that no settlement of labour questions can be stable which is not founded on uniform justice, and which does not make its justice and fairness evident to both employers and employees. Force may triumph for an hour, but reason alone can maintain an abiding rule. As Mr. O'Connell puts it in the following article, to which these paragraphs are but an introduction and preface, coercion, as between managers and men, whenever and wherever it is applied, is sure to fail in the end. It is with the earnest hope, therefore, of aiding in bringing about an understanding between manufacturers and workmen that THE ENGINEERING MAGAZINE has opened its pages to the leading exponent of American organised mechanical labour, and invited a statement of the views of the machinists' union upon the newer systems of management and the plans of wage-fixing, which, from the employees' point of view, are thought to be fairest and most enlightened. The side of the employer has been ably and often stated in this magazine, in many relations and under various lights. Mr. Orcutt, Mr. Jeans, Sir Benjamin Browne, Mr. Slater Lewis, Mr. Henry Roland, Mr. Norris, Mr. Hoyt, and many others have argued the case in papers whose strength was impressive and whose spirit of fairness and desire for justice must have been apparent to all. Mr. O'Connell, as the official exponent of the views of organised American labour, has been asked in the same spirit to join in the discussion, and to define the attitude of the employee—to show wherein his estimate of the situation differs from that of the manufacturer, why he opposes methods and movements which to the employer appear indispensable, and what alternative he proposes sufficient to meet the needs of the case and the evident tendencies of modern production. For the first requisite of agreement is mutual understanding of one another's views and of the approaches by which they have been reached.

THE ENGINEERING MAGAZINE, however, adheres firmly to the opinion which it has consistently maintained and to which it has frequently given editorial expression—that the irresistible tendency of progress in industry is toward intensity of production and toward differentiation of the individual; and as the piece-rate and premium systems are in direct accord with these principles, they seem certain to prevail in spite of the fear and the disfavour with which they are now regarded by the labour party. If they did indeed foster all the evil tendencies summed up by Mr. O'Connell, they would need no organized antagonism to overcome them; they would die of themselves, like discords, killed by their own internal conflicts. It would certainly seem to need some positive demonstration that they do so direfully affect the nature of the worker under them—that greed and cupidity are stimulated by a fair opportunity to do better work for more wages; that Jekyll becomes Hyde when he strives to make fuller use of his own natural faculties and the mechanical equipment provided for him; that the milk of human kindness remains sweet in the individual who turns ten castings a day on his lathe, but sours in him who tries by more careful attention and forethought to turn eleven or twelve.

If there were in fact but a fixed amount of work to be done in the world, by sharing which accurately a limited number of artisans could eke out a living, the strong man who in his strength jostled his weak brother aside, that he might secure more than his own share, might receive condemnation, but that fallacy was too long ago thrown onto the scrap heap to be brought out again. It is universally true and almost as generally recognised that every cheapening of production brings a more than proportionate increase of consumption. There is no greater benefactor to the whole race, from a material point of view, than the man who, by diligence or inventiveness, makes one hour of labour suffice for the work which formerly took two. His blessing is like in kind and great in proportion to his who makes two blades of grass grow where one grew before.

And in the machine trade the reward is peculiarly direct and cumulative, for the reason that, as some one has observed, the machine tool is directed to the processes by which itself was made—the tool, to a large extent, makes other tools. If the designer or the operator can make it turn out these new tools more cheaply, there is, first, an enlarging market for the product, more of the manufactured tools bought, more operatives needed to carry on the tool manufacture; but there is, next, the parallel increasing demand for new operatives to tend the manufactured tools. More tools built, more tools occupied in building—more machinists to care for both; the reward comes home immediately to the machinists' trade, which enjoys, further, its proper share of the generally reduced cost of living and increased scale of comfort which attends every improvement in manufacturing processes.

The movement toward the utmost intensity of production is only another cycle of the progress which began with the introduction of machinery. The effort to resist it is as futile as the opposition to steam has long since proved itself to be. Almost every step of the advance of power-using has been fought against the opposition of labour, more or less organised if only by its common fear that it was about to be crippled or even destroyed. The direct outcome of that steady, and sometimes cruel, advance is the enormous body of mechanical labour the world over, a body of which the powerful organisation represented by Mr. O'Connell, and its kindred union, the Amalgamated Society of Engineers in Great Britain, are only chapters. One need but read the logic of events to see that the triumphant future of the machinist lies forward in the same path. To attempt to crystallise conditions as they are now is inevitably to become atrophied, fossilised—extinct. This is the sort of "coercion" which everywhere and always will irresistibly prevail. It is not coercion of the employee by employer; any attempted coercion of the employer by the employee it will finally and surely overcome by counter-pressure. It is the inflexible coercion of evolution, forcing employer and employee alike along the same path. The things which are in accord with it will prosper, serve their uses, and eventually give place to still more highly adapted institutions; the efforts which oppose it will certainly go down in more or less complete ruin as they prove finally less or more adaptive to the inevitable.

This may seem a picture of:

> " * * Nature, red in tooth and claw
> With ravin, * * "

but such a view will hardly stand against the calm marshalling of the facts. "Intensified production" carries no inevitable corollaries of greatly increased bodily labour, of physical fatigue and mental exhaustion. The constant and rapid tendency in every line is to emancipate the manual worker, to free the muscles and to a very great extent the mind of the labourer. He directs—the machine *does*. The number and range of machine-shop processes in which the operative is an overseer only is on the rapid increase, and even the oversight is being continually made easier. Not only the tireless energy of steam or electricity, but the never-sleeping thought of the master mechanic are animate in the tool. The tool attendant is relieved to a maximum degree of physical and mental strain; his part in the scheme of enlarged output is largely one of watchfulness and forethought—of skill in setting and adjusting, of promptness in removing finished work and supplying new, of anticipation of conditions soon to arise and preparation for them. The difference between turning or milling ten pieces or twelve is *not* twenty per cent. more muscular force expended, with a like increase in bodily fatigue and brain fag; it is more likely one of greater attention to securing properly sharpened tools from the tool room, to care in setting them, to the use of the machine at the best rate of feed and cut, to foresight in arranging for supply of new blanks or castings, and to the avoiding of delay from the inability to secure the helper or the use of the crane at the proper time. No one can go through a modern shop without being impressed by the large amount of time which remains at the disposal of the average machinist of today, free from engrossing care—free for the cultivation of his skill by study of his work with a view of improving his tool or the method of using it—free even for broader and less-specialised mental cultivation, if he prefer it.

It is certain that industrial evolution is not going to stand still at its present phase. More product, and better product, at less cost per unit is the invariable law, whether the product be breadstuffs, transportation, or the manufactures of the workshop. If this be a goad, then manager and man alike must work under the goad. The industry or the shop which best fulfills this inexorable requirement will thrive, and in its prosperity will furnish profitable employment to the most workers; the establishment, the institution, or the country which fails will be overcome and will die. And no effort to eliminate the individual and reduce all to uniform mediocrity, amiable as its motive may seem, can hope to prevail.

We are passing through an era of astonishing mechanical development. New machinery demands—and irresistibly demands—new methods of management. At every point of introduction, labour-saving machinery has met precisely the opposition which is voiced in Mr. O'Connell's paper. In every such contest, without exception, that opposition has gone down before the inexorable logic of necessity. So it must be with the piece-rate system—with every new system which marks an improvement over the old. "The survival of the fittest" is the inexorable law—in methods, as well as in mechanics.

PIECE-WORK NOT NECESSARY FOR BEST RESULTS IN THE MACHINE SHOP.

By James O'Connell, President International Association of Machinists.

I KNOW of no more discordant or unpopular note to strike in the whole gamut of economics than that of piece-work. Cover it up as you please—call it what you will—if you introduce the subject at any meeting of workingmen called to discuss labor economics, it has the same effect that a red flag is popularly supposed to have upon a mad bull. If there is any tendency manifested to go to sleep, introduce the subject of piece-work. The most somnolent become wide-awake, and the gathering that a few moments ago was placid as a mothers' meeting has become a pandemonium. There is never any variation. It has always the same effect. It is not a popular subject; it never will be so long as those who have experienced its baneful results are alive and able to bear testimony against it. I was never more convinced of this than I was at the last convention of the International Association of Machinists, which was held in Buffalo, N. Y., in May of last year. Nor have I required any further evidence than was there presented.

The premium system, as advocated by Mr. Norris,* was at that time receiving a great deal of attention both in the ranks of labor and among the manufacturing employers. I had been in correspondence with the gentleman upon the subject, and felt at the time that if the plan advocated was honestly tried and its promises honestly lived up to, it might prove of great value in reducing the friction that always asserted itself when anything in the nature of piece-work was hinted at. Imbued with this idea, I proposed that Mr. Norris' plan be endorsed temporarily; that it be given a fair trial, and if found to do all that its originator claimed for it, that no organized antagonism from our organization should check its progress or usefulness in the future. Then the storm broke. And it was not an ordinary one—it was a cyclone. When the storm blew over, Mr. Norris' premium plan—or rather the motion to endorse it—was beyond resuscitation.

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* The history of this particular instance, which is cited by Mr. O'Connell as a "leading case," was fully written in THE ENGINEERING MAGAZINE by Mr. H. M. Norris, in his papers on "Actual Experience with the Premium System" appearing in the issues for January and February, 1900. Those who are interested are referred to these articles for additional information.

Many pitiful tales were told of similar fair promises that were only made to be broken; of harmonious relations that existed between management and employee—of fraternal intercourse of shopmates that prevailed before the introduction of the piece-work blight, and of the rude awakening that came when too late to check the insidious disease; of the greed that it awoke and encouraged in the most unexpected places; of its immoral tendencies—its promotion of discord and demoralization; of how it warms to life the cupidity that seems to be latent in the most seemingly perfect of natures, and of how it created an ishmaelitic like doom for all who were changed by its blighting influence—one man's hand raised against the other—in a fierce competitive struggle; of how the most generous-hearted of shopmates became the most penurious, and how the peculiarity was developed that characterized the horseleech's daughter—a desire for "more"—in men who had never before shown any symptoms of the miserly instinct. All this was told, and told in a way that carried conviction, for it was told by men who knew of what they spoke—men who knew by sad experience.

Now, I had submitted my report to our subordinate lodges, as our local branches are called, some weeks before the convention, and in my report I had entered very fully into the premium plan. I had published it in its entirety as it had been given me by Mr. Norris, so that all the delegates were thoroughly posted on the subject. Not only were they posted themselves, but they represented and reflected the majority thought of their constituents. In introducing the subject I had said:

"One of the most important matters to be considered by the delegates to this convention is the question of piece-work. There is no denying the fact that piece-work and the premium plan are constantly growing in our trade. Although we have succeeded in instances in preventing the introduction of piece-work, yet its volume is increasing. It is useless for us to any longer refuse to squarely face the matter. There is no one who believes more firmly than I that piece-work is detrimental to our trade; it not only works injury to the tradesmen, but results disastrously to the employer.

"We allow our members in some shops to work under the system; although the same firm may own the shop across the street, our members cannot accept the system there under our constitution. When we go to employers with this state of affairs existing we are placed in a most ridiculous position.

"During the past two years we have spent more money and devoted more time of the officers to the question of piece-work than to any other portion of our trade.

"A new plan is now being tried in some localities which, in the main, does away with the old practice of piece-work, and introduces what is known as the 'premium plan' of paying for work performed. This guarantees to the men that they will receive their regular wages whether the same is made by them or not."

(Here I quoted Mr. Norris' plan.)

"The delegates to this convention will fully appreciate that some definite action must be taken as to our position in the future regarding the introduction of piece-work and premium plans. In my opinion, it would be the wiser policy for us to face the inevitable, select the best system, then control it. I am satisfied if this is done we can rapidly unionize a large number of manufactories which we are now constantly fighting."

It will be seen by this that the matter had had the opportunity of being thoroughly ventilated and discussed in the locals prior to the convention, and it was not the individual sentiment of the various delegates that was expressed, but the concentrated opinion of the International Association of Machinists. There was a special committee appointed to report on this special part of my report and they reported as follows:

"Recognizing the great inroads that the premium plans and the two-or-more-machine systems are making into the machine shop of the present day, we believe it is essentially necessary that legislation of a definite nature should be enacted whereby the International Association of Machinists can successfully manage and control them. We realize that to further combat the system of premium plans will be suicidal on our part when we consider the fact of the many members of our organization being engaged in them at the present time.

"Your committee realize that this is a knotty problem to solve in presenting a plan whereby we can successfully deal with this question on the start. We do believe, however, that the plan herewith submitted will, in a measure, serve as a guide wherever the system is in operation, or may be introduced in future. We might also add that practical experience is the greatest teacher in all things, and during the next two years we will get the benefit of it, at which time we will be better able to amend or improve the plan herewith submitted.

"Members of the International Association of Machinists can accept premium work under the following conditions:

"First. That each employee shall be guaranteed his regular day's-work wages.

"Second. That the time limits shall never be lower than the average time made with the same tools under the day's-work plan.

"Third. That no one shall be discharged because of failure to reduce his time below the limits.

"Fourth. That, in addition to his regular wages, each employee shall be paid one-half of his regular hourly rate, for each and every hour he may reduce his time below the prescribed limits.

"Fifth. That the limit, once fixed, shall not be lowered except through the introduction of new methods of doing the work.

"Sixth. That all the premiums shall be paid within two weeks of completion of the work, upon which they were earned.

"Seventh. That at the end of one year's time the plan will be withdrawn from all those not wishing to continue under it.

"Eighth. That, if withdrawn, the employee shall not be required to work at the same rate of speed without an equivalent in wages.

"Ninth. Any member of the International Association of Machinists working at the premium-work system shall not be permitted to earn more than 10 per cent. in excess of the average wage paid in that locality. Shop committee shall ascertain each day the amount earned by each member under the premium-work system. All over 10 per cent. he may earn shall be forfeited to the lodge of which he is a member, and report same to the Financial Secretary of the lodge."

The report was unanimously rejected, or practically so, in spite of the fact that its favorable reception was advocated by the committee, and from the published proceedings I cull the following:

"The President then addressed the convention, saying that after great study he felt that it was his duty to bring this matter up, as the manufacturers of the country are making strenuous efforts to introduce the piece-work system. He then explained the difference between the piece-work system and what is known as the premium plan. He reported several interviews with firms, and advised the convention to adopt some law that would allow the officers of the International Association of Machinists to cope with this evil. He referred to the article of Mr. Halsey, editor of the *American Machinist*. Said he hoped some means would be devised to regulate this system."

But the storm to which I have already alluded was on, and the plan was swept aside.

The thing that struck me with the greatest force was, that no matter what scheme is proposed in the way of so-called profit sharing, it is an impossibility to get it accepted with anything like unanimity by the workers, so long as their experience of piece-work is more than a memory. And any scheme to be successful must be accepted voluntarily; it must not be forced. If it is, it will be futile. Coercion, at all times and in all places, will prove abortive; the more you force obedience to any system that is as antagonized as the piece-work system is, the less you will have of it, the less the chances of success.

Its enforcement will breed disorder in any shop, whether the employees are members of a labor organization or not. If they are, they will offer organized resistance, in which they will be in receipt of the sympathy and assistance of their fellows elsewhere; if they are not, they will degenerate into a species of serfdom without any of its redeeming features.

There is another thing in connection with piece-work that is not generally known by the employing manufacturer—if it is, I have never seen anything to show it—and that is, with the introduction of piece-work in the present well organized condition of the trade, would come some form of limitation of production. There is no limitation of production now, nor has there ever been to my knowledge, official or otherwise; but if the piece-work principle was successfully enforced—and it could not be without great loss to both employer and employee—the trade union would be driven to adopt some measure of retaliation and protection, probably similar to that adopted by the Amalgamated Society of Engineers in Great Britain. And so much fear has been expressed lately that the trade union would decree how much work a man should turn out in a day, that I think this view of the situation is worthy of consideration by those in whose ideas of successful superintendency is included the introduction of piece-work.

Over a quarter of a century ago the Amalgamated Society of Engineers recognized the great possibilities for evil that existed when a man's selfishness was tried by the piece-work system of ethical education, and counteracted it by the following law:

"Any member taking work by the piece, and not sharing equally, in proportion to his wages, any surplus made over and above the weekly wages paid to members and other persons working on such job, shall be summonsed, etc." Then follows the penalty for violating this law.

Then to stop connivance—supposing the management was not above that sort of thing—on the part of a timid man who might be afraid of losing his job if he stood out for his share of the surplus mentioned above, the following was enacted:

"Any member working for or under a piece-master, and not receiving an equal share of any surplus in proportion to his wages that may be made over and above the weekly wages, he shall be summonsed before his branch * * * and, on his refusal to leave such employment, he shall be fined in the first instance twenty shillings ($5) and for the second offence excluded."

Rather drastic means to inculcate unselfishness, but at the same time, I have no doubt it was meant to teach discipline as well. At present, I am led to understand, no member of the Amalgamated Society of Engineers is allowed to earn more by piece-work than thirty-three and a third per cent. over his daily wage, or, as they put it, equivalent to time and a third. If laws like these are detrimental to the interests of the employer, piece-work, and piece-work alone, is responsible.

This way of looking at piece-work may appear sentimental to some, but the principle is strongly condemned, and has been, by eminent sociologists who have made a study of the labor problem. Condemned on the ground that it encourages over exertion, overtime, exploitation, and the sweating system. In some trades it enables employers to hire more help than they require. That tends to uncertainty of employment, a surplus labor market, and the consequent ruinous competition of the unemployed. For it is an undisputable truism that the man out of a job—the man on the street—dictates what wages shall be paid. When one-half of the laboring community does the work of the whole, the employers of labor make use of the redundant labor so created, to compel those who are employed to work for less pay.

This may be considered the ideal state by the employer of labor, but the employee thinks differently; hence the rooted antipathy to piece-work, no matter in what guise it appears.

Perhaps it might be asserted—and with a certain degree of justice (but only a slight degree as I will show presently)—that the universal introduction of piece-work into the machinists' trade could never give the employer of labor in that particular calling an opportunity to hire, or keep hanging on in hopes of a job, more help than could be permanently employed. This assertion ought to be accepted without question if nothing was ever produced except what was ordered by the consumer; but the whole trend—the very essence—of modern production, is to accumulate a surplus—to make stock—so that any sudden demand can be furnished at once. Whenever a manufacturer starts on stock he has the opportunity, should he feel so disposed, of creating a labor surplus. I have known this to occur, and the employer to pose as a philanthropist while doing so, making the plea that there was no demand for the product, though out of the goodness of his heart he was making stock so that he could give employment to the men—*at reduced prices.* Of course, his certain hope of an eventual market had nothing to do with his philanthropy.

Aside from this, even were it not so, the trade-union movement endeavors to overthrow, or at least to minimize, existing evil conditions wherever found; and knowing that this evil exists to a lamentable degree in other crafts, it is denounced by ours.

Take the garment workers for instance. Piece-work to them has meant, and does mean, degradation. It furnishes an example of how the employer is enabled to partially employ double the number of people that are required to produce his output, so that he is enabled to use one-half of those he employs as a club to beat the other half into the acceptance of any piece-price he may feel disposed to offer. Piece-work, in this case, creates the bitterness of uncontrolled competition between workmen, and has intensified the bitterness of the struggle for bread. The conditions of life, which were not too roseate at any time for the garment worker, have become worse than they were and more deplorable, through the piece-work evil. Because of this immoral tendency, we are opposed to piece-work on principle and will never be a willing party to its propagation. Trade unionists are not alone in this. An awakening society echoes every word of bitter protest that has been said against the rigors of this devouring system. The organized portion of the machinist craft can never be pointed at, if they can help it, as being a party in sympathy with an evil that has demoralized any wing of the army of labor. We will not accept anything, either by countenance or approval, that is degrading, or tends to the degradation of the worker.

I have often asked myself whether the average American machinist really requires a goad to make him do a day's work, and I have honestly come to the conclusion that he does not. He has been so often told that his brother in Europe worked so much harder than he, that he has finally accepted the statement as a fact, and keeps up the high pressure at work, which, along with his skill, is his chief characteristic. I used to believe the same thing. But I now know that both he and I were misinformed. The British machinist—or engineer as he is called—does not work so hard, nor does he make any pretence of doing so, as does his brother mechanic on this side of the Atlantic. I know whereof I speak, for I made a very careful study of the question last summer in England, Scotland, and Ireland.

I do not know anything of the conditions on the continent of Europe from personal observation, but I do know that, no matter what these conditions are, and no matter what speed the continental workmen manage to keep up, nor how many hours a day they labor, Great Britain successfully competes with them in the machine markets of the world. This being the case, I have come to the conclusion that a goad is unnecessary to drive the average American machinist.

But, though a goad is at this time unnecessary, the time has come when a stimulant would not be an injury. The long, many, and tedious hours of toil, and the high pressure at which he has worked, are bound sooner or later to assert themselves, and his productive power will not be so great as formerly, just the same as the enervation of age tells upon a man's output now. Then it will be necessary to provide a stimulant to keep up the admirable *esprit de corps* that has made the American machinist and his product the wonder of the world. What shall the stimulant be?

First, we must find out what effect a reduction of the hours of labor by one hour per day would have. Then he must be taught that the employer has at last come to the conclusion that the possibility exists that he—the employer—may not always be right and that the employee may not always be wrong—that there is a possibility of mistake and misunderstanding on both sides which might be amicably adjusted if they met with mutual patience and respect.

Then we must find out how he lives and where he lives—in what numbers and by what chances; if his life is monotonous we must see that the monotony is varied; there must be no more sameness—he gets enough of that during his working hours. He requires sunshine as well as shadow, and we must see that he gets a generous share of it. We must treat him as a man—a man with all the hopes and joys, the fears and responsibilities, of manhood. We must cease to talk of him and write of him as if he were a part of the machine he manipulates. And we must not do anything that would retard his progress or reduce his standard of living, for both are necessary to the prosperity of employer and employee.

Let us stimulate him in this way and he will require no goad, other than his awakened and newly appreciated intelligence, to produce to his full capacity. Do this, and the peaceful methods of evolution will succeed in benefiting all, where the barbarity of piece-work created chaos. Do this, and both workman and employer can achieve all their desires without having recourse to any measure or system that is repulsive to human nature and disastrous to their mutual interest.

THE ELECTRICAL EQUIPMENT OF THE TALL OFFICE BUILDING.

By Reginald Pelham Bolton.

BY the term "office buildings" must be understood the largest class of buildings for which New York City has become noted, and which, by reason that many of them stand on restricted areas, have been extended in the vertical direction to considerable heights, and are thereby familiarly known as "sky-scrapers." The electrical problems therein are directly due to the two features of magnitude and altitude.

Such buildings are indigenous to America, but the interest which their construction has aroused in Europe, and especially in London and Paris, may be expected to lead to the adoption of some of the methods which have been developed in order to meet the novel conditions they have demanded. Further, the electrical equipments in such very large buildings exceed the proportions of usual private installations and compose a new class more of the nature of small central stations, serving, as they do, a body of residents equal to that of a small town, with a transient traffic running into thousands. With the public central supply, therefore, the tall-building equipment comes into sharp competition, and since the demand for such equipments may be expected to spread wherever business demands the office-machine or modern business-building, the comparison of their economies should be of interest in many communities.

While the lighting of such buildings is required by modern demands to be electrical, it has been, and may to some extent continue to be, a consideration open to considerable question whether the electrical method can be extended with economy to the operation of the elevator service. The arguments for this extension are condensible into the following, but the facts which the experience of the past few years have demonstrated, and which should be properly weighed to decide this important matter, are not so readily stated, yet when stated will be found to bear strongly against the extension.

It may be asserted that electrical elevators are more economical *per se,* that a further gain is obtainable by operation in conjunction with lighting work, and that the generating plant required is the additional cost of a single generator unit; also, that there is a general advantage in the combination of all services under one character of power; finally, that the service can be operated by outside supply without the expense of installing a generating plant.

These assumptions have been the cause of much disputation, and in a number of cases where incompletely studied have led to decisions in favor of the adoption of electrical operation of elevator machinery. The results of the use of the electrical high-speed machines are now before us and can be briefly summarised as follows:

Without the addition of a storage battery, the high-speed electric elevator is not so economical as the hydraulic.

The additional cost of a storage battery, with interest and depreciation thereon, outweighs any economic gain obtainable.

Without a battery, the service cannot be combined satisfactorily with lighting work.

A higher class and greater extent of labour is necessary with electrical-elevator machines.

The cost of maintenance and repairs is largely in excess of the same items with hydraulic machines.

The cost of outside electrical supply is too great to admit of economical consideration in this class of building.

The reason for this disappointing result, to my mind, is to be found in the basic fact that this service is a radically unsuitable application of electricity. The irregularities of the service are extreme, much more exaggerated than those of any surface railroad. They are illustrated in the following diagrams of fluctuations of a five-elevator and of a six-elevator service.

If this fluctuating service were necessarily conducted at large or varying distances from the source of power, the electrical method might, and probably would, exhibit superior advantages, as is the case in trolley service; but in elevator service the generator and the application are so closely connected that the question of friction scarcely enters into account.

Storage of power, or reserve force, is obtained in a much cheaper form in the case of hydraulic power than is within the range of probability in the electrical. A pressure-drum suitable for a five-elevator plant costs about $850, and with piping and appurtenances the storage will not cost more than $1,500, while an electrical storage battery to accomplish equal results could not at present be purchased for less than $12,000. The life of the hydraulic storage is practically unlimited, certainly not exceeding a depreciation of 1½ per cent., while a battery must be debited with a depreciation account of not less than 7 per cent. It is probable, therefore, that the attempt to operate schedule elevator services by electricity will not extend much beyond the cases already installed, except in instances where some possible special desirability of the operation by outside electrical supply, for night service, or for breakdown, is considered to outweigh the addition of operating cost and maintenance.

Passing to the consideration of lighting work in these buildings, the problem by itself becomes rather a simple one. The extent of lighting is increasing, but is still subject in large degree to the vagaries of architects, whose system in this matter, as in others relating to engineering subjects, is largely to copy the errors of their own previous efforts or those of others which appear to them to present parallel features. Thus it has happened in numerous cases that large additions to lighting loads have had to be added after the building is filled with tenants, while in others the unnecessary multiplication of lights has led to a permanent cost for useless current.

The location of outlets is a matter in which technical experience and study are well repaid, and while the former may direct much of the arrangement, a consideration of each office room is required to reach a proper decision as to the probable position of furniture and light. Many buildings also are liable at some later period to lose a large part of their outside light from the erection of other tall neighbours, and in nearly all cases that part of the light which is obtained by windows in the party-wall (commonly known as "stolen light") is liable to entire closure, in which case certain rooms will in future be entirely dependent on artificial illumination. When all these points have been decided, the outlets should be arranged so that they take corresponding positions on the respective floors, forming practically similar installations on each floor.

In such a case the "vertical" arrangement of wiring, which I designed for the Bowling Green offices of 3,200 outlets, is a means of great economy in first cost as well as of advantage in construction and maintenance. In this method the circuits are run up the line of corresponding outlets connecting to distribution centres in the cellar. The distance between outlets is thus reduced to the height of one floor, whereas in the ordinary system the average distance apart would be not less than one-fourth of the extent of walls or partitions of each office. The precise effect is best appreciated by the reduction in cost, which experience in several installations has shown to be not less than 30 per cent. in favour of the "vertical" system.

There are incidental advantages to be added, such as the absolute drainage of the vertical conduit pipes and the concentration of fuses and switches in the engineering space. For the above reasons it is not practicable to give a definite figure of the amount of lights or the relation of number to floor area usual in this class of building, but some comparisons may be made from the following:

	Inhabitable area.	Contents.	Lights.
Bowling Green Offices	247,000 square feet	4,915,000 cubic feet	6,300
R. G. Dun Building	99,000 square feet	1,250,000 cubic feet	3,800
German-American	78,000 square feet	1,330,000 cubic feet	2,000

The character of the lighting load is peculiar, and consists of a very light day load, with a sudden but short evening load averaging 70 per cent. of the maximum, and with infrequent but abrupt maximum loads during day darknesses, such as those preceding sudden thunderstorms and still more rare days of dark fog. For such work a division of the generating units into three usually best meets the requirements; and, preferably, three units of unequal sizes. The very short period of heavy load is such that I have not found any obtainable economy in compounding the cylinders of generators.

The security and desirability of a storage battery has to be considered, and its cost compared with other methods of security and economy. As regards the former, it may well be conceded that the insurance against breakdown afforded by a storage of power outweighs considerations of cost, and conditions are to be found where this feature will decide the adoption without further consideration.

In considering the question of economy, the storage battery suffers always by reason of its large prime cost, to the interest on which must be added the known rate of maintenance. In the lighting only of office buildings it does not gain by any reduction of labour, and is further at a disadvantage by reason of the demand for waste steam for heating purposes during the winter season.

Although in connection with elevator service it is essential and its economy over direct operation is unmistakable, for lighting work it can be credited only with the saving of one generator in cases where the plant would otherwise require three, since two are necessary to maintain the standard of duplication generally adopted for purposes of security in office buildings. There may also be an economy in the cost of any outside supply of current, which may with a battery be taken at the lowest rates, when proportioned to be charged during hours of light station loads. But, inasmuch as the lowest present rate of station supply is largely in excess of the cost at which equal supply can be generated in the building, there is little advantage to be gained by this service, other than as affording some additional security.

The usual tension employed at the lamp is under 120 volts, but there has been considerable recent discussion of the desirability of the adoption of a tension of 220 to 240 volts. In favour of such an increase in tension is first, the uniformity of system where motors are employed, these being practically standardised at the higher voltage —and secondly, the reduction in copper and in size of conduits. As the latter item, which is not considerable in these buildings, is outweighed by the reduced efficiency of the higher-tension lamps, the consideration filters down to the desirability of uniformity, which, in the case of the installation of electric elevators, becomes of sufficient weight to justify a decision in favour of the higher voltage.

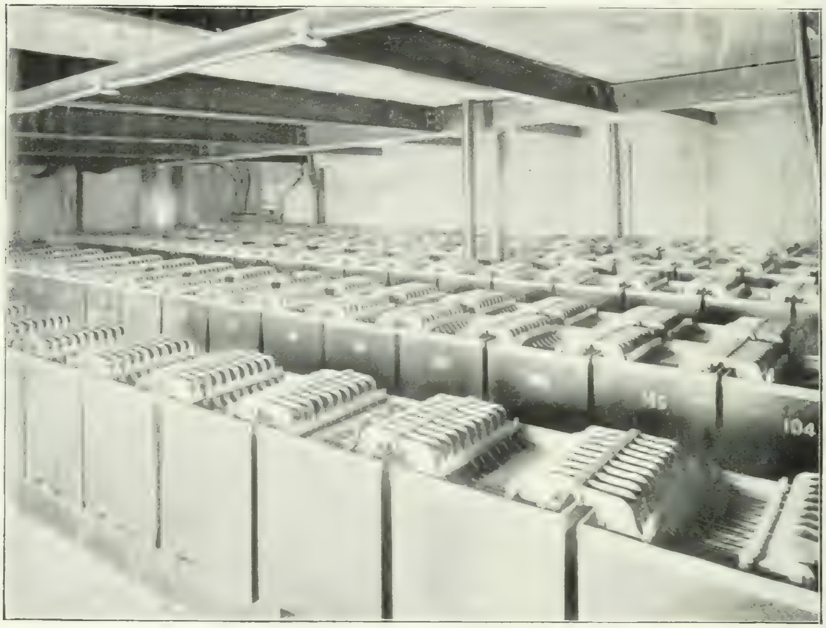
The outside supply service in New York being three-wire, the arrangement of straight two-wire feeders and circuits does not conform to the desirable division of the load of a large building on the two sides of the three-wire system, and the load must be sub-divided to some extent at the switchboard.

The 220-240 volt lamps are now greatly improved, but there remain some small troubles with fuses and circuit breakers which have to be overcome.

The assertion that, under office-building conditions, the generation of electric supply can be made more cheaply than by outside supply companies, has been contested by the champions of centralised electrical generation but cannot be controverted; and the best answer to their arguments is that I am prepared to show that a number of office buildings can afford to sell current to the illuminating companies during their hours of maximum night load and entire day loads. I have had before me the figures of a number of office buildings, and in all the cost of electrical generation is very much lower than the lowest rate of outside supply, and it may be concluded that until current can be supplied to such buildings during the hour of maximum load at less than two cents per kilowatt hour, it will not enter into competition with the internally-generated supply.

To accomplish this result, I take the view that the supply companies must themselves provide, as part of their system, storage batteries of such proportions that their charging may be done at the hours of lightest station load only, and they must dispose of their waste steam at a certain value, or provide its value to this class of building in the shape of reduced cost of electrical supply.

The storage battery has for years struggled against the adverse circumstances of costly material and limited use. It is the power-supply companies to whom the battery presents the largest source of advantage, and it is their wide application of it at storage points to meet individual requirements that will eventually produce the demand which will operate to reduce the cost of manufacture. It will not suffice merely to install batteries at the central station—they should be feeders to all dead ends of the supply system. With such a system widely enough adopted, the average load line of a central station might be raised to the economical heavy load during the entire day and night, and such an increase of output would enable the service to be sold at competitive rates during all but the winter months.



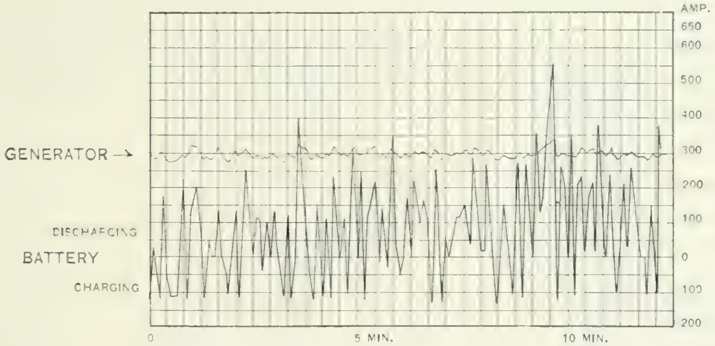
CHLORIDE BATTERY, R. G. DUN BUILDING, NEW YORK.

An instance exists in the case of the large battery in the Bowling Green building, belonging to and operated by the New York Gas, Electric Light, Heat & Power Co., which is charged from the Duane Street central station during hours of light load, and feeds its district during the same time, at full pressure, helping to maintain this service and pressure by discharging in parallel with the station during hours of heavy load. Incidentally it supplies the Bowling Green offices in which it is situated at the rate of 4½ cents per kilowatt hour, but as it happens to pay rent for space occupied a comparison in this case is not conclusive. Assuming, however, a building having about 4,000 lights and adopting the supply of an outside company:

The first cost of an electric plant would be	$12,000
On this, depreciation, repairs and interest amount to	1,160
Labor and sundries	1,640
Total directly chargeable to cost of electric supply	$2,800
The yearly electrical service would amount to about 181,500 kilowatt hours, which the building could generate for about 450 tons of coal, say	$1,350
Add interest and labour account	2,800
	$4,150

Of this, part of the coal represents useful work done for the heating of the building, but even making no allowance for this purpose, the cost is near 2¼ cents per kilowatt hour. To purchase this supply at 4½ cents per kilowatt hour would cost $8,167.

As the standing charges would not be increased if the generators were run full load all day, the building could well afford to sell current for the cost of coal, of partial interest and depreciation, and some profit, which could, therefore, be done at a rate not exceeding 2 cents per kilowatt hour.



ELECTRIC ELEVATOR LOAD WITH BATTERY

AN ILLUSTRATION OF THE FLUCTUATIONS OF DEMAND OF A SIX-ELEVATOR SERVICE.

R. G. Dun Building, New York. The variations are carried by a storage battery, resulting in practically uniform load for the generator of 100 k. w. capacity (420 amperes at 240 volts).

If the work of heating could be taken up by the supply companies, a different complexion would be put upon the figures discussed, and

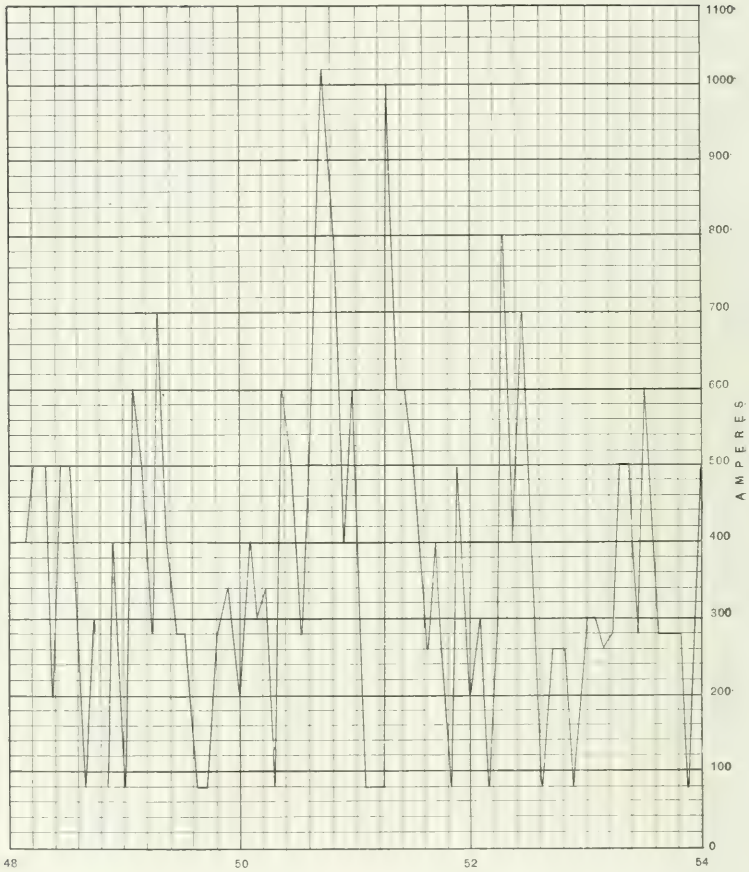


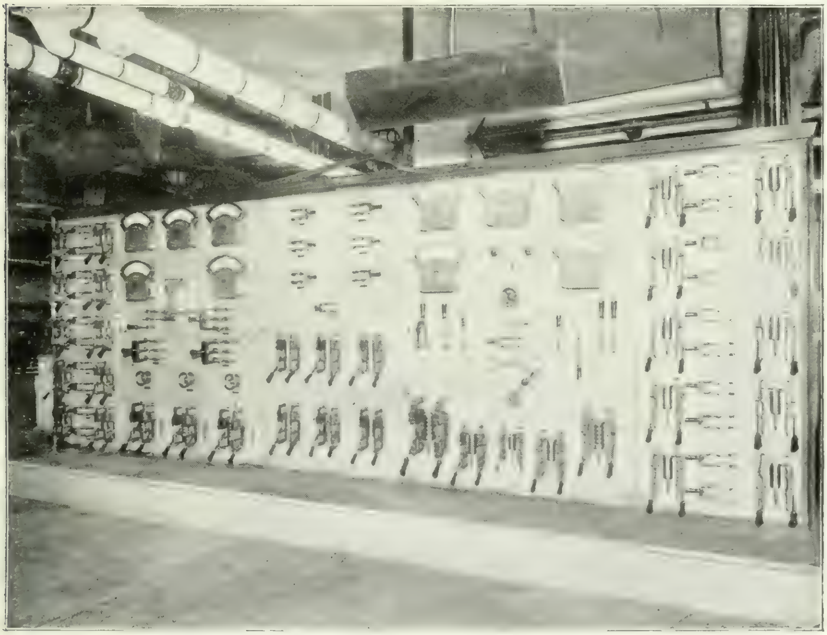
DIAGRAM OF FLUCTUATIONS OF LOAD DEMANDED BY FIVE ELECTRIC ELEVATORS.

Carried by direct-connected generator of 100 kilowatts capacity (800 amperes at 125 volts). Lord's Court Building, New York.

an overwhelming addition be made to the adoption of central-station energy. This is only practicable by the utilisation of the waste steam of the station, when a product now practically useless would become a source of profitable income, and, as a combined proposition with electric supply, could be made to compete so far with an independent plant that the majority of owners of this class of property would find its adoption of advantage.

They could afford to pay for the combined services a sum equal to their coal bill, the interest, depreciation, and repairs on the entire plant, and all of the wages account excepting that of, say, one engineer and an assistant.

In the case of such a building as referred to above, the general cost of operation for elevators, lighting and heating, and house pumping service for a year, including interest and depreciation, will amount to $10,970. If operated as suggested, this is all that the owner can be expected to pay, and for this the supply company must provide:



SWITCHBOARD OF THE R. G. DUN BUILDING, NEW YORK.

For elevators, lighting, and battery; three generators, booster, and supply company's connections.

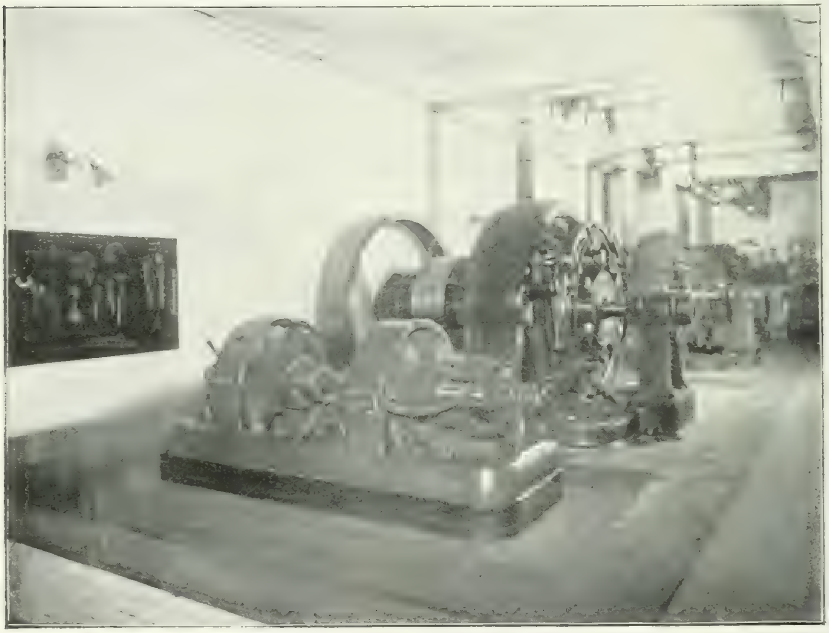
Elevator service	135,000 kilowatt hours
Light	181,000 kilowatt hours
The equivalent, in steam, of	4,200,000,000 B. T. U's

Wages one engineer and assistant. These four items must not exceed:

Elevator service at 2 cents	$ 2,700
Lighting service at 3 cents	5,430
Waste steam at 34 cents per million	1,428
Wages	1,412
	$10,970

Not until these rates can be afforded with a profit in the sale will independent plants in office buildings cease to enter into competition with the central station.

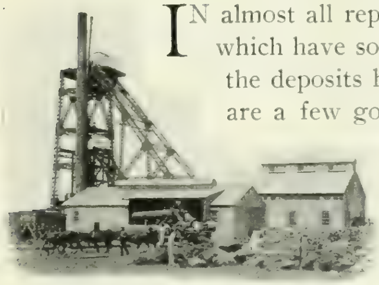
The interior economy of the organisation of large central-supply companies is not an open book, but it is evident that, even if most economically managed, the secret of their inability to compete with well-proportioned independent plants lies in the large standing expenses which they are compelled to maintain for the purpose of supervision, inspection, clerkage, collections, banking, and in the interest and depreciation of their extensive and expensive systems of underground mains, none of which enter into the cost of an independent plant. Therefore, until their business is so large and so economically administered that the proportionate part of these expenses, which must be charged against each consumer, is less than the interest and depreciation transferable from the owners' little plant to the station-plant conduits and pipes, and that part of his small wage account capable of transfer to the central-supply station can be utilised to produce there equal or more productive work—so long will the central supply suffer in comparison with office-building economies.



LIGHT AND POWER GENERATORS, AND BOOSTER FOR BATTERY CHARGING.
R. G. Dun Building, New York.

DUTCH GUIANA FROM A MINING STANDPOINT.

By J. Esdaile Florance.



IN almost all reports of gold placers in Dutch Guiana which have so far been made current, the wealth of the deposits has been vastly overestimated. There are a few good properties which, in the hands of experienced mining men, can be made to pay. At the time of my visit none of the placers was in operation, owing to the unusually dry season, which was remarkable even for that country, no rain in sufficient quantities to be serviceable having fallen for nearly a year. There are so many difficulties to overcome that it is advisable for capital to be extremely careful of mining investments in the country. The intense heat, the surety of malarial fever in its worst form, labour, which is extremely difficult to obtain and control owing to the peculiar laws governing miners, the extreme difficulty of transportation—all must be given due consideration, and will be referred to further on.

I reached the country by steamer from New York to Grenada, proceeding thence by Dutch steamer Wilhelm IV. via Port of Spain and Demerara to Surinam. Port of Spain is singularly beautiful, situated among fine hills. The Queen's Park Hotel is the most magnificent of any in that part of the world, and is surrounded by tropical trees, plants, and flowers; opposite to it are the golf links, cricket grounds, and the governor general's mansion, where the regimental band gives afternoon concerts. There are but few whites, and those who are there are English. There is, however, a large foreign population—coolies, Hindoos, Javanese, Japanese, and many other nationalities wearing their native costumes. Demerara, being settled by the English, is more like one of our own towns and hence less striking to a stranger.

Dutch Guiana or Surinam is a colony of Holland. It is situated on the northern Atlantic coast of South America, occupying, with British and French Guiana, the territory between the Amazon and Orinoco Rivers. Paramaribo is situated on the Surinam River and is the chief seaport. There are a number of fine cocoanut and sugar plantations at this place whose products, in connection with the fine

A SECTION OF A GUIANA PLACER MINE

tropical fruits, furnish the principal source of revenue. There are some very handsome residences, and the governor's palace is situated facing a large square. Sunday afternoon the band concert draws a remarkable crowd, most interesting to the stranger, as all nationalities are represented. Handsomely dressed ladies may be seen walking behind bush negroes in their full dress, consisting of a freshly oiled body and a breech-cloth, the principal part of their decorations being their hair, which is wrapped with twine and stands up all over their heads like the quills on a porcupine. They are a magnificently developed race of men. The Javanese, Japanese, Chinese, coolies, Hindoos, native negroes, and in fact all the globe is represented, but at first glance one would imagine he was attending an unusually fine circus parade.

The organisation of the expedition party, which consisted of a Dutch foreman and fourteen native negroes, consumed six days. We left Paramaribo in a steam launch chartered for the occasion, taking in tow a fifty-foot fishing boat, with provisions and baggage. There were also, on our launch, two Dutch engineers and eighteen men who had asked our permission to share the launch and who were going further up the river, representing the Company Surinam, who have large concessions from the Dutch government in consideration of their agreement to build a railroad through the virgin forests of Dutch Guiana. It is to be noted that, upon the failure of any of the natives to meet their annual taxes on mining property, the property reverts irrevocably to this company.

Boschland, the point at which we left the Surinam River, is about sixty-five miles from Paramaribo. On account of the extremely low stage of the water we stuck several times on sand-banks, finally abandoning the launch when about two-thirds the distance had been accomplished and taking to our boat, which was rowed by six men using sweeps. The Dutch engineers got into a large canoe, their men using paddles, the crews of both boats, singing their native songs, each vieing with the other to obtain the lead. This lasted for some time, when we stuck on a bar and the Dutch party, having the lighter boat, left us.

After repeating our experience with the sand-banks innumerable times, we finally arrived at Boschland about six o'clock in the morning. This point is a Dutch government police station and is situated on a bluff standing about twenty feet above the river in the dry season, though I was informed that in the rainy season the river often overflows its banks. Our men were too fatigued with their exertions to attempt anything further that day, so all hands rested. The next day

PORTION OF GROUND WASHED FOR PLACER MINING.

the men went into the bush with two weeks' provisions, carrying about fifty pounds on their backs in a kind of knapsack made of twisted bush rope, which is used altogether in that country to take the place of twine and heavy cord. It hangs in large quantities from the trees and is, of course, a great impediment to progress through the bush, as, unless you continually use your cutlass to clear the way, it becomes entangled in your feet and is of sufficient strength to trip you. The following day the men came back for another load. The next morning the owner of the property, the promoter, and I started for the camp at seven o'clock. After crossing fifteen hills from two hundred to five hundred feet high, some of them extremely steep, we arrived at three o'clock in the afternoon, very much fatigued by the walk, on account of the intense heat. We sent part of the men back for freight, and started the rest of them at building a camp.

PIPE LINE TO THE RESERVOIR OF A PLACER.

Upon walking over a portion of the property, I found a great scarcity of water. The creeks, so far as investigated, show indications of having been very thoroughly worked. The question confronting us was whether or not the gold extends back from the creeks. I saw no indication whatsoever on this property of quartz lodes. I started to make a thorough examination, with the result that pannings occasionally showed small indications of coarse gold, ranging from two grains to thirty-eight grains. After putting down a number of pits on the side of the creek, I found about five feet of alluvial soil, one foot of clay, and from eight to twelve inches of the so-called pay gravel, which consisted of a very tenacious clay, pieces of white quartz, and in some cases a small quantity of iron-stone. In all my examination, in only one pit did I find sufficient indications to warrant further investigation, and this was at a point where the creek made a turn and had been overlooked by the former operators. Having satisfied myself that the creeks had been thoroughly worked, and that it was evident that the report of the great richness of this property had emanated from this source, I undertook to find out whether there was any gold back from the creeks. This was accomplished by sinking a series of pits and, in one case, running directly back from the creek a ditch four feet wide, eight feet deep, and one hundred and twenty feet long. There a long tom was set up and, by means of an Edson pump which I had taken with me (and which I wish to recommend most highly for exploration purposes), I forced water which had been reserved in a dam for this purpose about seventy-five feet, and started to wash the dirt, with the result that we did not find even a trace of gold. As this was invariably the case in every pit put down away from the creeks, I found after two weeks that there was absolutely no use of continuing the examination. As a placer proposition the property was utterly valueless.

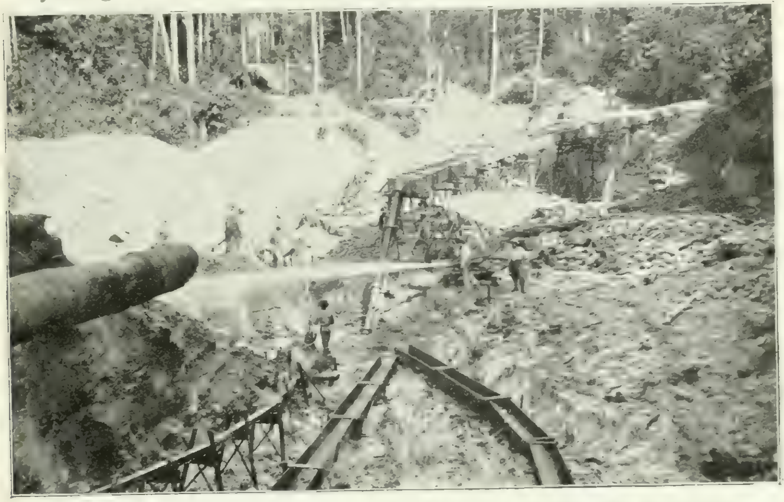
RESERVOIR OF THE MULLER AND DE JONGE PLACER

The ground is covered with heavy timber and the tropical vegetation of such density that it would take an engineer and a number of men perhaps a year or more to say absolutely there was not a quartz lode on the four hundred hectares, but so far as my judgment is concerned I can say confidently there was not the slightest evidence that such was the case. The samples of white quartz from the tailings when assayed show no trace of gold. How the white quartz got there is a problem which has puzzled all visiting engineers. The most valuable property in Dutch Guiana, at the time of my visit, was undoubtedly the Muller and De Jonge placer. In hydraulicking there they ran across a lode which apparently is of great value. I did not examine this property, as it was under bond to a Holland syndicate, but a number of photographs which are of great interest accompany this article. Mr. Muller showed me some wonderfully rich quartz taken from this lode at a depth not exceeding forty feet. In fact, I have never seen more beautiful specimens of gold quartz. The mineral reports of this property show that between 1883 and 1894 654,000 grammes, valued at $392,400, had been taken cognisance of by the government. They recently erected a hydraulic plant; on the first run of 159 hours, it is claimed, it produced 659 ounces of gold, valued at $11,862.

The managing director of the Surinam Bank told me, in course of conversation, that Mr. Muller had a short time previously refused $400,000 in cash for this property. The Von Hemert placer also produced, between 1884 and 1892, 1,619,850 grammes, valued at $896,928.

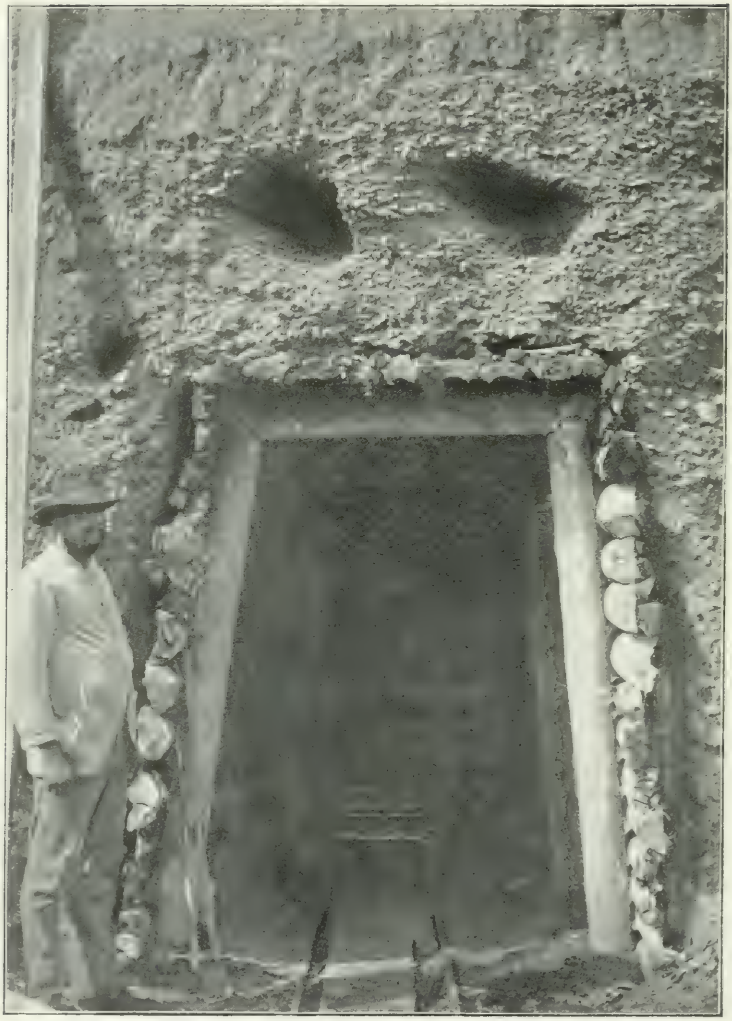
HYDRAULICKING WITH GROUND SLUICES.

The natives, who are mostly negroes, do all of the mining and the returns are made in small amounts from the creek washes and aggregate quite a large sum during the year. These people, inured to the climate and living at a minimum of expense, with primitive appliances are able to make money where a company would be unable to do anything whatsoever.



HYDRAULIC PLANT IN OPERATION SHOWING GIANT, SUMP, AND ELEVATOR.

After a careful investigation, I am of the opinion that it is not advisable at present to invest in the country, although unquestionably, sooner or later, some rich lodes will be discovered nearer the mountains, which at present it is almost impossible to prospect. Grant that a prospector is fortunate enough to find a rich lode; the labour in itself is such a serious question that I am extremely doubtful if success could be made under present conditions. In the first place, it is necessary to advance two weeks' pay to the men and a contract is signed which apparently binds for an agreed time, but in fact is of little or no value, as upon taking them to the bush, if they claim sickness, the employer is obliged to send them to Paramaribo at his own expense. The government specifies their provisions, and the law favours labour as against the employer. Wages amount to about sixty cents American currency per day, and their food to about forty cents per day. One American miner can do more work than four of them, so there is really no economy, although on paper it would seem so. The climate at Paramaribo is quite healthy, there having been no epidemics for years, but upon leaving the river and going into the bush, the malarial fever in its worst form is inevitably met. Not a day passed that some of my natives were not laid up with it, and I was very seriously ill. The



ENTRANCE TO AN EXPLORATION TUNNEL.

water supply is another very serious difficulty, there being practically none for mining purposes during the dry season without an immense expenditure to bring it from the Surinam River; in the wet season, on the other hand, the river is completely out of its banks and everything is flooded out.

THE PARIS EXPOSITION AS A MECHANICAL ACHIEVEMENT.

By Edmund Mitchell.

INTERNATIONAL exhibitions, which are intended to illustrate and commemorate the progress of mankind in every country and in every sphere of industrial activity, must be themselves progressive. Each new venture of this description must beat the record established by its predecessors, or admit itself beaten. There can be no going back; diminished effort, diminished expenditure, diminished magnificence in the results attained, would be contrary to the spirit that animates the enterprise, and would spell inevitable failure.

Therefore, it has been with keen anxiety that France, and with sympathetic interest that the world generally, have been asking whether the city of palaces that has sprung into being on the banks of the Seine for the year 1900 is going to eclipse the vanished but never-to-be-forgotten glories of that other city of palaces which during 1893 shimmered, white and beautiful, on the shores of Lake Michigan. The task which Chicago set to any friendly rival courageous enough to organise the next World's Fair was a formidable one; but while the Exposition buildings in Jackson Park were still standing in all their dazzling splendor, Paris boldly accepted their silent challenge and announced her intention of playing hostess to the nations in the closing summer of the century. She has had seven years to bring the gigantic undertaking to completion; her guests and coadjutors are on the eve of pronouncing the verdict.

That Paris, with her matchless reputation for art and good taste, and her accumulated experience derived from four previous Universal Expositions, should come triumphantly through the ordeal depended perhaps less on material than on political considerations. The period of preparation has been a perilous one—one of bitter and continuous

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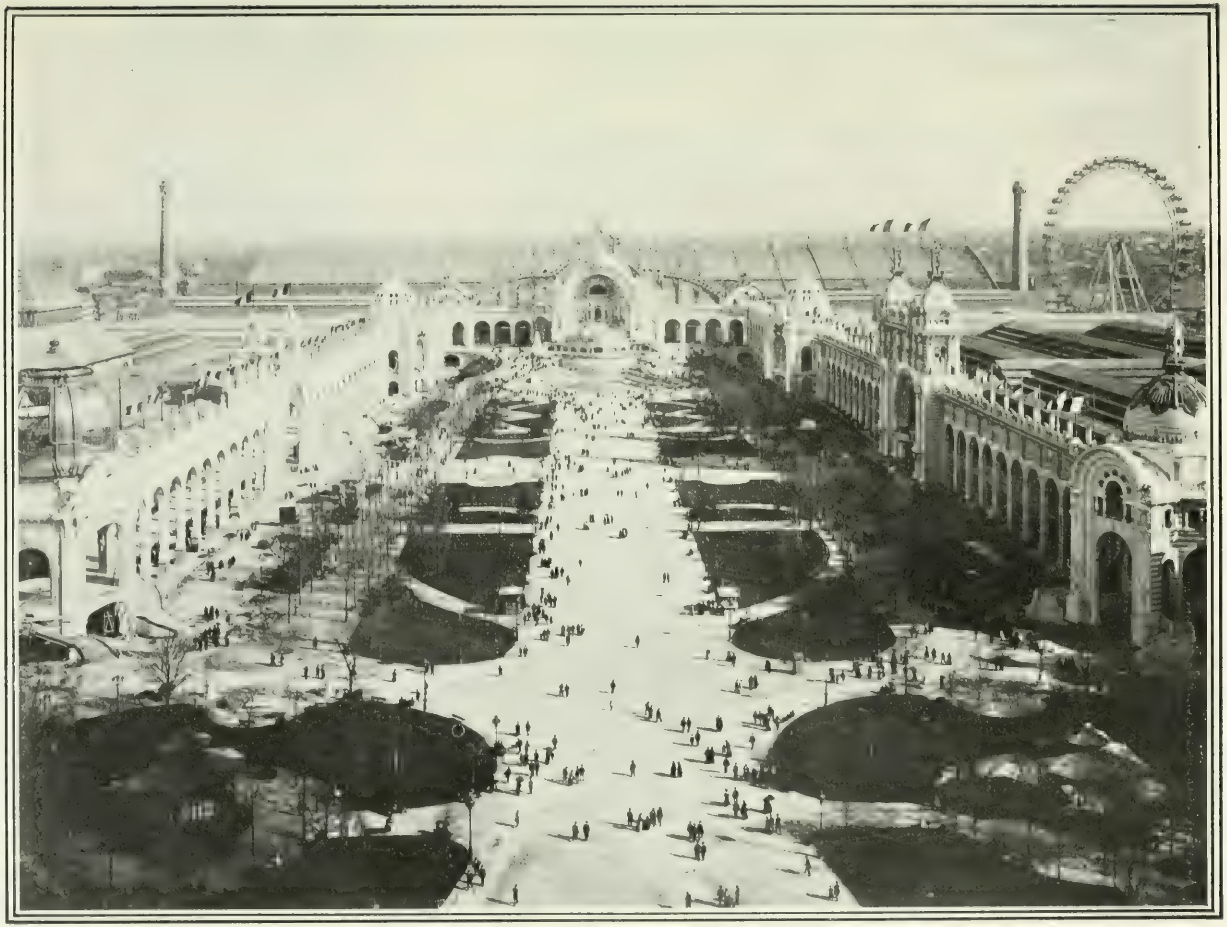
The conduct of a great exposition is an example of works management on its hugest scale. Every problem of arrangement, equipment, power development and transmission, internal transportation, organisation, discipline and accounting appears at its maximum. From this point of view alone, the study is most important. Mr. Mitchell's article will be followed by a specialised treatment of the power features of the Exposition.—THE EDITORS.

internal dissension and of spasmodic threatenings of war. But the storms have been weathered, and the success of the enterprise is now assured. For there can be but one judgment pronounced—the Paris Exposition of 1900 surpasses anything of the kind the world has ever seen. To this result all the nations have generously contributed, not merely as a duty to themselves and their industrial producers, but as a sincere pledge of cordial feeling towards the French Republic. The United States, the friend of a hundred years; Germany, the enemy of yesterday; Russia, the ally of to-day; England, which unscrupulous mischief-makers would designate as the antagonist of to-morrow—these, and every other civilised country, great and small, have joined hands in securing for France her victory of peace. And all will unite in expressing the fervent hope that the Exposition, which, while yet in making, served the Republic at more than one crisis as excellent national ballast, will now, in being, still further bring down the load line and ensure continued and increased stability for the Ship of State.

Comparisons are proverbially not in the best of taste, but in the case of International Expositions they cannot be avoided. I have voiced the general opinion by saying that Paris in 1900 establishes a record; yet there are points for which Chicago is still entitled to retain her laurels of 1893. The charming landscape effects that were possible in the wide demesne of Jackson Park are unattainable in the detached and comparatively circumscribed areas that have had to be utilised in the French capital; even the silvery Seine cannot take the place of Lake Michigan's broad expanse of sunlit, rippling waters; and while the Champ-de-Mars may present a grander spectacle, it still leaves undimmed the memory of the chaste and classic architecture of America's Court of Honour, with the gleaming dome of the Administration building closing the one vista and the graceful peristyle that so perfectly completed and yet did not terminate the other.

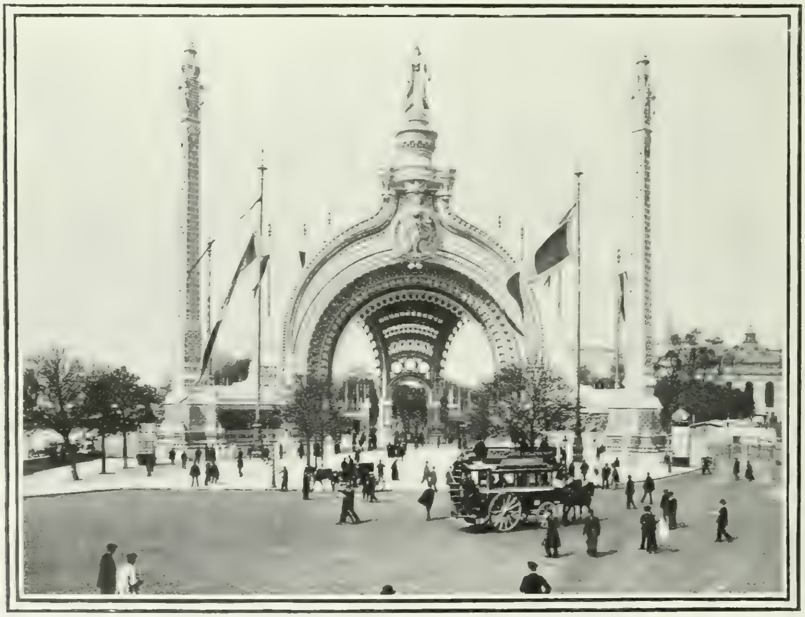
But the relative disadvantages as regards site with which the organisers of the present Exposition have had to contend are, with consummate taste and genius, eventually made to contribute to the successful results attained. Paris itself is pressed into the service, and becomes an integral part of the Exhibition. Isolated spaces are linked together, and ribbons of gay buildings bind each and all into one harmonious whole. The Seine, that might have divided, becomes with its permanent and its temporary bridges an impounded waterway that most certainly ought to have been artificially constructed had nature left it out of the scene. The Eiffel Tower, which if a masterpiece of mechanical skill is none the less a hideous monstrosity, now seems



THE CHAMP-DE-MARS, SEEN FROM THE EIFFEL TOWER.

The uncompleted building on the left is the Palace of Mines and Metallurgy. The Chateau d'Eau, forming the façade of the Electricity Building, closes the vista. The ornamental chimneys over the boiler houses are on each side, beyond.

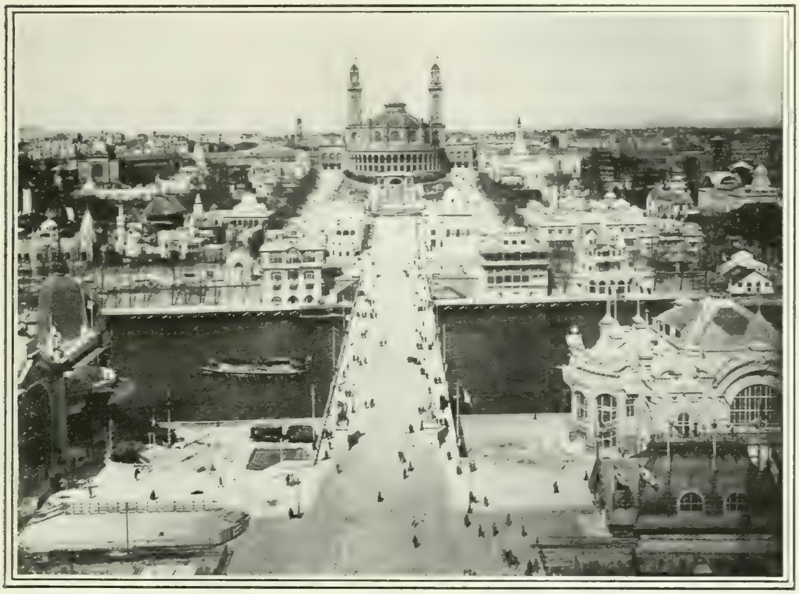
quite appropriately to look down benignantly on the younger and smaller brood of domes and minarets, steeples and belfries, that crowd around. The Palace of the Trocadero, admittedly the ugliest public building in Paris, at last is placed in a setting where it becomes a veritable thing of beauty, its twin towers dominating from the hill on which they sit the marvellous aggregation of Asiatic, African, and Polynesian structures that crowd the gentle slope of the gardens beneath. The crowning architectural gem of the French capital, the gilded dome of the Church of Les Invalides, under which rest the ashes of the great Napoleon, is made to close a superb vista formed by an esplanade between two Exhibition palaces that might otherwise have been constructed as one, a richly decorated court, the new bridge of Alexandre III. with its ornate statuary, and then the broad tree-shaded avenue that separates the two stately Palaces of Art. At the main entrance the vast Place-de-la-Concorde, with its monuments, its fountains and its Egyptian obelisk, has been left untouched; yet it seems placed, proportioned, and adorned, all in accordance with design. The unrivaled foliage of the Champs-Elysées and of the Tuileries Gardens equally appear to be incorporated in the picture. Thus it is that Paris herself becomes a part of her Exposition, the perma-



THE MONUMENTAL ENTRANCE

nent and the temporary being welded together with an art that has never been excelled.

It will be evident from what I have written that the scene as viewed from one of the Seine bridges is of marvellous beauty and interest. Individual buildings may suffer from being somewhat crowded, but the general effect is thereby enhanced. On the one side of the river is Old Paris, with its quaint and picturesque structures; on the other is the Street of the Nations, every edifice in which, modern or mediæval, is of striking and characteristic design; all around and beyond are the magnificent Exposition palaces proper; in the distance is the curious congeries of minarets and domes that bespeak the presence of artificers from many remote corners of the earth. Such a *coup-d'oeil* could have been presented only on a comparatively restricted area; concentration of space was essential to its almost bewildering completeness.



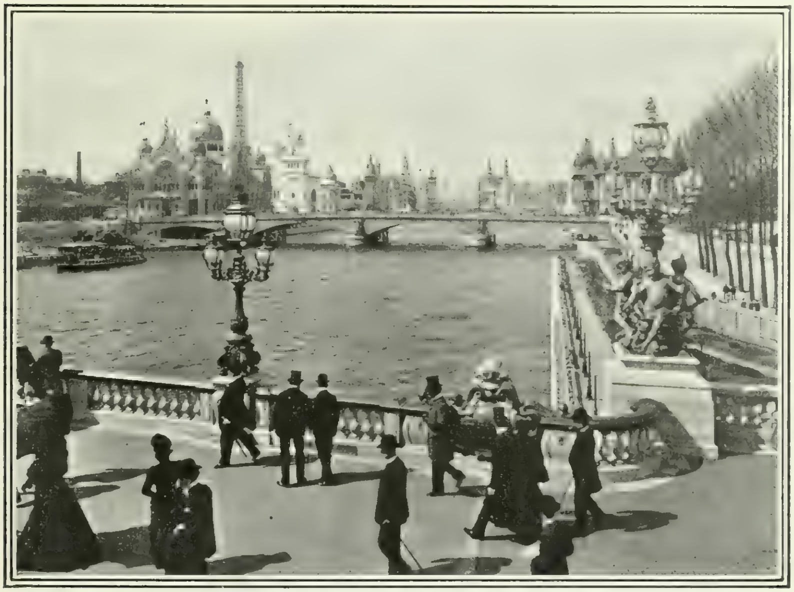
THE TROCADERO GARDENS FROM THE EIFFEL TOWER.

French colonies to the left, foreign colonies to the right.

Many visitors will also count it an advantage that the distances between all parts of the Exposition are not too great. Numerous detached areas have been incorporated, but riverside embankments, bridges, and avenues bring all into communication. Moreover, what might at first sight be considered a drawback is skilfully turned to useful account, for the natural subdivision of the grounds is made to lend itself to a convenient grouping of the buildings. This rough classification not only saves sight-seers from fatigue by enabling them to view the entire display in sections and on different days, but it further results in a different keynote being struck, so to speak, in the various quarters of the Exposition.

THE BRIDGE OF ALEXANDRE III., CONSTRUCTED WHOLLY OF STEEL.

Thus, on the Champs-Elysées Art is in the ascendant; we have here the highly ornamental if not altogether successful Monumental Entrance, the pavilions of Horticulture and Arboriculture, the city of Paris building, the Congress Hall, and the two great palaces filled with works of painting and sculpture. Crossing the Seine, by the Bridge Alexandre III., we reach the Esplanade-des-Invalides, where in two immense twin buildings, the one reserved to France, the other apportioned among all other nations, are displayed the million and one articles produced by a thousand and one manufactures; Industrial Enterprise is dominant here. Continuing our tour of the grounds and now descending the river, we pass along the Street of the Nations, a double row of sumptuous and diversified edifices where Embassies from every land dwell together, welcome visitors, and proclaim the sentiment of "the Brotherhood of Man." But almost by way of ironical contrast we next enter the long mammoth structure devoted to deadly engines of war, military and naval; the spirit of Strife now pervades the atmosphere. Our itinerary then brings us to the Champ-de-Mars, where, around three sides of an elongated parallelogram, are ranged the palaces of Mines and Metallurgy, of Textile Fabrics, of Mechanical Engineering, of Agriculture and Food Products, of Electricity, of Chemical Industries, of Civil Engineering and Transportation, of Education and Instruction, and of Letters, Sciences, and Arts; in this quarter Inventive Genius is all supreme. The open end of the parallelogram, that next the Seine, is occupied by the Eiffel tower, round which are clustered minor displays of a more or less educative character, such as a huge globe showing the planetary system in motion, and a panorama giving the illusion of an actual voyage along the shores of the Mediterranean; Amusement is beginning to rub shoulders with Education. Re-crossing the river, we are in the Trocadero Gardens, where French and foreign colonial exhibits are gathered together in picturesque pavilions, mosques, kiosques, and entire villages, in which natives from a score of distant lands ply their trades,

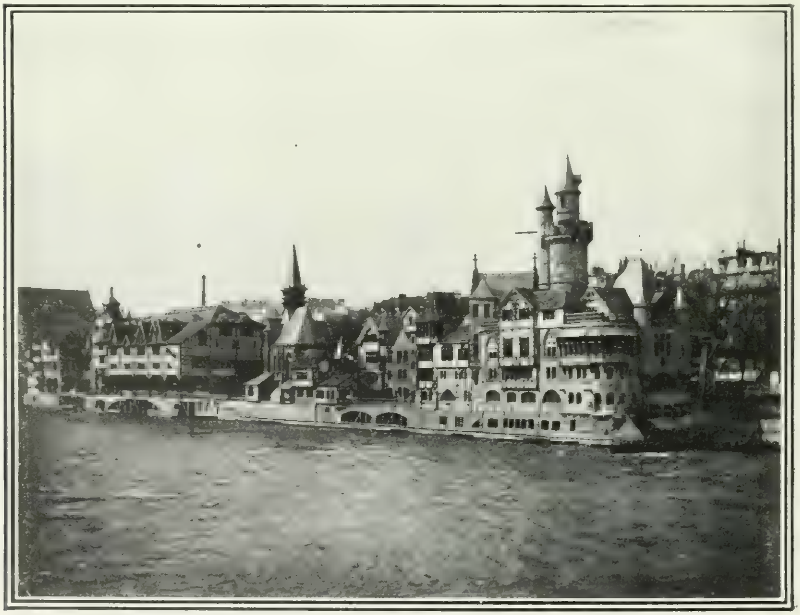


VIEW FROM THE BRIDGE OF ALEXANDRE III.

The lofty dome appearing near the Eiffel Tower belongs to the United States building. The Trocadero towers are in the mid-distance.

and dispense music, theatrical performances, and characteristic dances; Gaiety begins to rustle in the breeze. Ascending the Seine towards our original gate of entry, we pass through Old Paris, where the costumes, industries, and diversions of former days are revived in streets and buildings that are archæologically correct in every detail; here we have Merriment, with just a lingering touch of Instruction. Finally comes the Street of Paris, composed of theatres, cafés chantants, dancing halls, and numerous other establishments of a type essentially modern and Parisian; in this neighbourhood Revelry is to be allowed to run riot during the period of the Fair.

The above brief description not only shows the convenient grouping of buildings, but will also serve to convey an idea of the comprehensive scope and the immensity of the Exposition. To complete the sketch, it has to be added that in a spacious annex at Vincennes, the East End park of Paris, connected with the Exposition grounds proper by a special line of railway, sports of all kinds, including cycling and automobilism, have their displays, and in each department elaborate international tournaments have been arranged for the summer months. Here also are to be found the exhibits in the important classes of railway and tramway rolling stock, and of agricultural machinery; while the United States has a special building in which is in-



OLD PARIS.

THE STREET OF THE NATIONS, LOOKING DOWN THE SEINE.
A portion of the Italian building shows first on the left; then comes the Turkish pavilion, partly concealing the United States building, the portico of which is surmounted by the Goddess of Liberty in the car of Progress, with Washington's equestrian statue beneath.

stalled a magnificent exhibition of machine tools crowded out of the allotted space in the Machinery Section.

To return to the main grounds, it may be said that electricity in all its varied applications has been made the dominant feature of the Exposition. In the vestibule of the principal entrance, a statue of Electricity confronts the visitor; at night time here the triple archways are a blaze of multi-colored lamps, while searchlights from the flanking columns send their beams over city, river, and Fair. The Eiffel Tower becomes a colossal monument illustrating the progress that has been made in a single decade, for it is tricked out from base to summit with as many incandescent lights as sufficed for the entire Exposition of 1889. The moving sidewalk, with a course of nearly three miles, forms a popular object lesson of electricity utilised as a motive power; in this instance, however, the French engineers have forgotten the peculiar charm of noiseless operation, for the track is an elevated one, with the result that the persistent roar overhead, comparable only to the rumble of ten thousand wagons, reverberates like muttered thunder through the adjacent palaces. In the Machinery

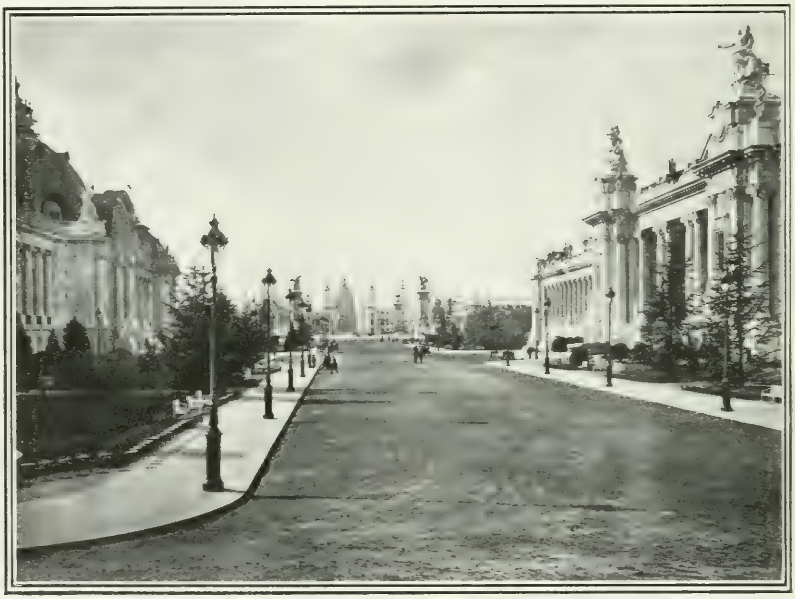
Hall, practically the whole of the power is distributed in the form of electric current. There are two great boiler houses, one at each end of the long building; the first has been installed by the French Government, the second by a syndicate of German firms. This latter circumstance helps to explain why on the day of opening the German machinery section was far-and-away the most advanced in the entire Exposition, for the practical, business-minded Germans had insisted on their space being handed over, roofed and floored, in ample time to permit of their part of the contract for supply of power to be fulfilled. Their gigantic travelling crane, operated by electricity, and busily engaged in completing the work of installation, soon became one of the great sights of the Exhibition. The total horse power provided is 20,000, capable of being doubled in case of need; of this amount, 15,000 horse power is devoted to electric lighting and 5,000 horse power to the operation of machinery. The two monumental chimneys that surmount the boiler houses well deserve mention; they are 80 mètres in height, have cost over 40,000 dollars apiece, and, both by their graceful design and by the use of encaustic bricks for decorative purposes, become veritable things of beauty, harmonising admirably with the general architectural features of the surrounding edifices. On the same level as the galleries of the Machinery Hall is the Electricity Building. Here, it goes without saying, the exhibition of electric appliances is one of magnificent completeness, not the least interesting pavilion being that in which the United States make a historical display of the newest practical science, with which their inventive genius has been so closely identified. The façade of the Palace of Electricity occupies the place of honour at the far end of the great rectangular space formed by the Champ-de-Mars; and it has been adapted to form what is termed the Chateau-d'Eau, which is unquestionably the great spectacular *"clou"* of the Exposition. A spacious and lofty hemispherical niche is crowned by an allegorical figure representing the Genius of Electricity, brandishing the torch of Progress, from which at night lightning flashes dart and dazzle. Beneath, the waters from condensing engines are turned to striking ornamental effect by being made to flow from a cascade a hundred feet high over a succession of richly sculptured basins. Myriads of electric lights and gorgeous fountain illuminations complete the scene, and render it one of unparalleled magnificence.

In an exhibition so vast, with many miles of galleries under roof and the grounds a crowded parterre of pavilions, it would be impossible within the limit of a single article to throw a comprehensive glance over separate sections and individual displays. One example may be taken, however, to indicate the thoroughness with which the work of illustrating particular national industries has been performed. I shall select the Transvaal exhibit, partly because of its intrinsic merit and partly because of the world-wide interest that the South African Republic is attracting at the present time. At no International Exposition of the past has there been such an elaborate reproduction of all the processes connected with gold mining, gold milling, and gold saving. Regular underground workings extending to over 500 yards have been constructed, showing in most realistic fashion a mine level in full operation. The walls are built of ore brought from the Witwatersrand, the reef is visible with hanging wall and foot wall, the systems of timbering and electric lighting are represented; there are shafts, cages, drives, stopes, chutes, tramways, etc.—everything complete. Above ground is a milling plant, with driving engines, ore elevators, rock crushers, a battery of five head of 850-pound stamps, amalgamating plates, and vanners, performing their different functions. Next comes a cyanide equipment, with tailings wheel, collecting tank, leaching vat, and pumping gear. Finally, we have the laboratory, where the delicate processes of precipitation, smelting, retorting, refining, and assaying are being carried on by expert metallurgists. The visitor thus follows the ore from the reef to the ingot. The complete-

THE STREET OF THE NATIONS, LOOKING UP THE SEINE.

ness, compactness, and intense practicality of this installation reflect the enterprise of the cosmopolitan city of Johannesburg.

As with all such Expositions, the Paris World's Fair will vanish in a few months' time. But no previous undertakings of the kind have left such a permanent impress on the cities that have given them brief but splendid existence. The massive Pont Alexandre III., constructed entirely of steel, will afford a much needed additional artery for traffic and a magnificent new approach to the Hotel-des-Invalides. The Art Palaces on the Champs-Elysées have been erected for all time, and will leave Paris with the finest picture galleries and museum building in the world. Two new lines of railway have penetrated to the Champ-de-Mars, one of them in its building having performed the important service of demolishing the worst thieves' dens and cabarets in the notorious Quartier Maubert. Then, the underground railway, which forms a perfect network of intercommunication, will be a precious legacy, relieving the boulevards and streets at present almost hopelessly encumbered with vehicles of every description. So, when the final débris of the Exposition comes to be swept away, Paris will find herself a much beautified and much improved city.



VISTA FROM THE ART PALACES ON THE CHAMPS-ELYSÉES TO THE DOME OF THE INVALIDES.

The Great Palace of Art is on the right foreground, the Little Palace on the left. The bridge of Alexander III., with its four ornamental columns, leads to the Palace of Manufactures.

DISAPPEARING GUN CARRIAGES IN THE UNITED STATES.

By G. H. Powell.

CURIOUSLY enough, though the disappearing type of carriage for seacoast guns had its origin in Europe, it is in the United States that it has reached its greatest development, while its use has practically been abandoned by the European governments. In fact, it has recently been stated in the public press, on the authority of a prominent English ordnance expert, that the consensus of opinion among artillery experts throughout Europe is utterly opposed to the use of disappearing carriages of any kind.

However this may be, the disappearing type of carriage plays a most important part in the mounting of the large guns of the United States coast fortifications, over ninety per cent. of the 8-, 10- and 12-inch calibers being on this style of carriage; so that for the present, at least, the country may be said to be committed to this type. And since this is the case, it may not be uninteresting to trace briefly the progress of invention which has led to the development of the disappearing carriage as used in the United States to-day.

The system of disappearing carriages appears to have originated with Colonel Moncrieff, of England, who patented his invention in that country in 1864, though the details were worked out by Sir W. G. Armstrong & Company. Colonel Moncrieff proposed that the enormous energy of recoil, or "kick" of the guns in firing—a pressure amounting to upwards of 35,000 pounds to the square inch—should be utilized in bringing the gun down into a protected position behind an earthwork, and at the same time be used in storing up sufficient energy to raise the gun into firing position after it had been loaded.

The "Moncrieff" mountings were so designed that a heavy counterpoise tended to keep the gun up in firing position. The energy of recoil was absorbed in lifting the counterpoise, and a ratchet and pawl kept the gun in the position to which it finally recoiled. In operation, each time it was fired the gun recoiled to the loading position, in which

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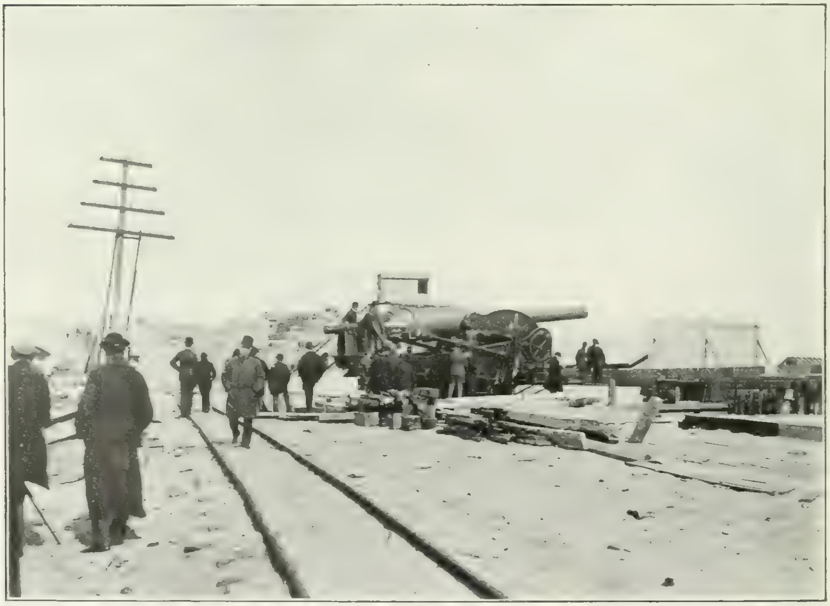
General Miles, the highest officer of the United States Army, under the President, has very recently expressed a sharp criticism of the policy of giving the disappearing carriage an overwhelming predominance in mounting the guns of the new United States coast defences. For this reason, and even more from the fact that the disappearing mounting represents an invasion of purely military science by advanced mechanical engineering, Mr. Powell's paper is especially pertinent.—THE EDITORS.

it was held until loaded, then, on releasing the pawl, the counterweight lifted the gun into the firing position, or, as it is termed, "in battery."

Some advantages of the disappearing-carriage system, belonging generally to the various forms which have been from time to time proposed—all of which, in a general way, conform to the foregoing description—may be briefly summarized:

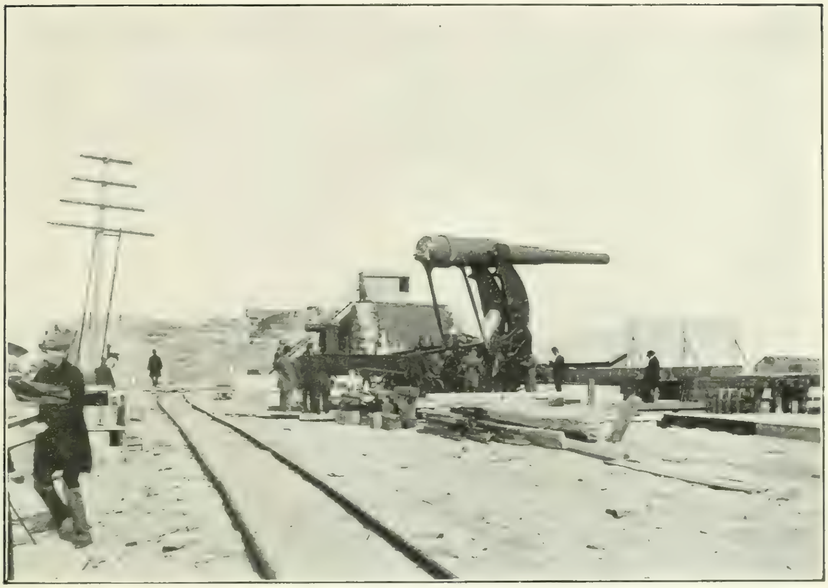
The gun is loaded, traversed, elevated, and worked generally in a pit or behind an embankment. While in the "down" position, in which the recoil places the gun, it is almost absolutely safe from any fire that can be directed against it by ships, and this protection is obtained without other means than earth and concrete, thus avoiding the use of heavy and expensive armor plates; to the advantage of unlimited protection afforded by the earth must be added the important feature of concealment, as it must be borne in mind that the glacis of the fortification—the only part visible to an enemy—can scarcely be distinguished from the surrounding country. There is, therefore, nothing to draw attention to the presence of a powerful gun which may be loaded and ready to appear for a brief moment to deliver its fire and then disappear from view.

A test of this system was made in England in 1885 by practice



UNITED STATES PNEUMATIC DISAPPEARING CARRIAGE.

The gun in the loading position.



UNITED STATES PNEUMATIC DISAPPEARING CARRIAGE.
Showing the gun fully elevated.

from H. M. S. "Hercules." A pit was dug and a model gun was arranged to rise up every two minutes, remain exposed for twenty seconds, and then sink down again; a puff of powder, fired just before the gun disappeared, made the conditions for the ship's practice exactly similar to those which would have been experienced had the gun been a real one.

The trial commenced by an attack of machine guns; hundreds of rounds were fired, but not a single bullet fell inside the pit. Broadside firing with heavy guns was next tried, and although the practice was good and some fragments of shell struck very near, the model escaped unhurt. Lastly, independent firing from the heavy guns was carried out, but the practice was bad and consequently the model was in no danger.* The trial was a thoroughly practical one and proved beyond doubt that a gun on the disappearing system is better protected than in any other manner.

When a ship engages a fort or turret she at least has the satisfaction of having something to aim at; but with a disappearing gun even this is denied to her, for with smokeless powder, such as is now used, and the gun in sight but a few moments at best, the vessel must take hard blows without being able to return them.

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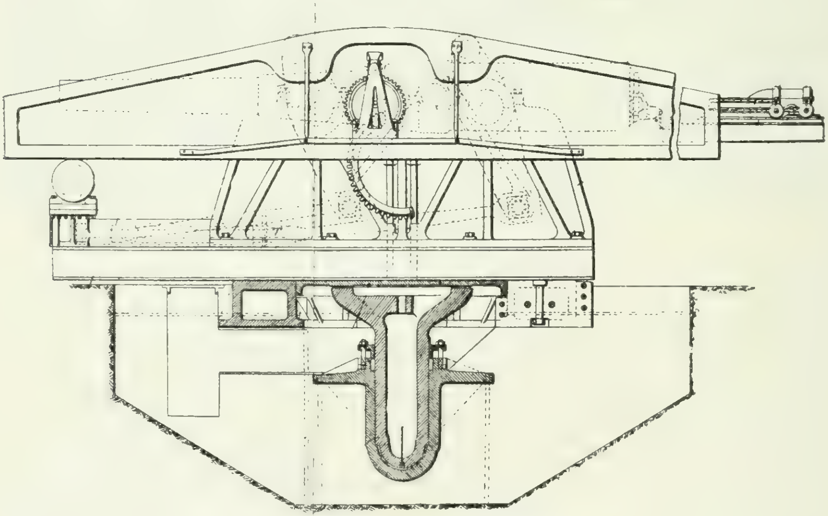
* See "Artillery, Its Progress and Present Position," by Lloyd and Hadcock.

Without stopping to trace the progress of the development of disappearing carriages in Europe, where their use in service has practically been abandoned, we will consider only the types to be found in the United States, where the system may be seen at its best.

The first form of disappearing carriage used in the United States was made after plans of Captain King of the corps of engineers. In this type the side plates of the main carriage, or, technically, the chassis, are inclined to the rear, and the gun and top carriage recoil down this incline and at the same time lift a counterweight, which is attached to the front of the top carriage by means of ropes passing over a fixed pulley placed between the front ends of the chassis rails.

SIDE ELEVATION, LOADING POSITION

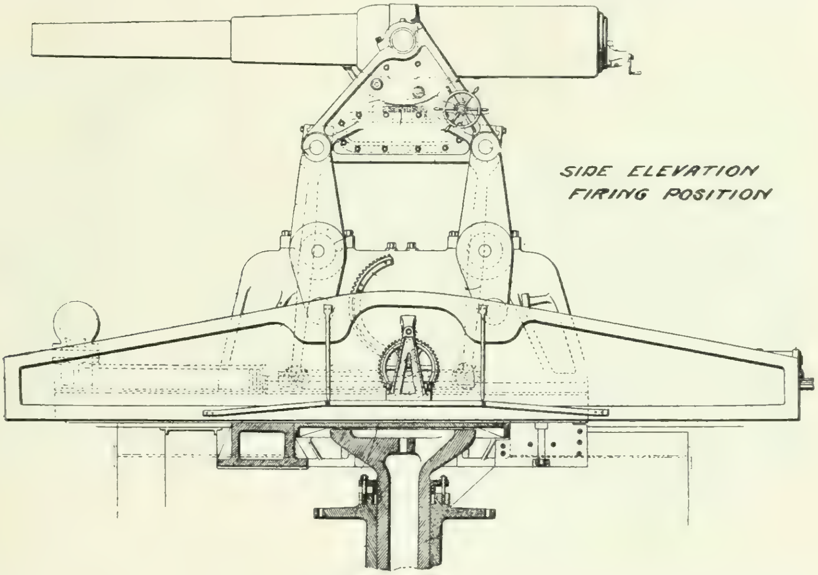


Gordon 10in Carriage

This form of carriage never came into general use, as it was not well adapted to the strains incident to the recoil of high-power guns.

The Pneumatic Gun Carriage and Power Company have constructed a carriage for a 10-inch gun in which all the motions of the gun are controlled by pneumatic power; that is to say, the recoil is taken up and the gun returned to the firing position by this means, and pneumatic power is likewise used in loading, elevating, and traversing the gun. A small reversible air engine is geared to the elevating and traversing devices. The loading device consists of a pneumatic lift for raising the charge to the breech of the gun and a pneumatic rammer for forcing it home. While this carriage may be said to work satisfactorily, it requires a steam plant for its service in compressing the air, which is used under a pressure of 1,000 pounds to the square inch, and, like the King carriage, it has never come into general use, though a second carriage designed by the same company is now nearly completed and will soon be tested.

Another form of disappearing carriage was that designed by Capt. W. B. Gordon of the United States ordnance department. It is a counterpoise carriage, the motion of recoil being transmitted through a series of lever arms to the counterpoise, which is of cast iron and placed on either side of the gun. This carriage has the advantage of an all-round fire, which is not ordinarily the case where a counterweight is sunk in a well beneath the gun. An examination of the photographs will more clearly indicate the design. Like its predecessors, it has never come into general use.

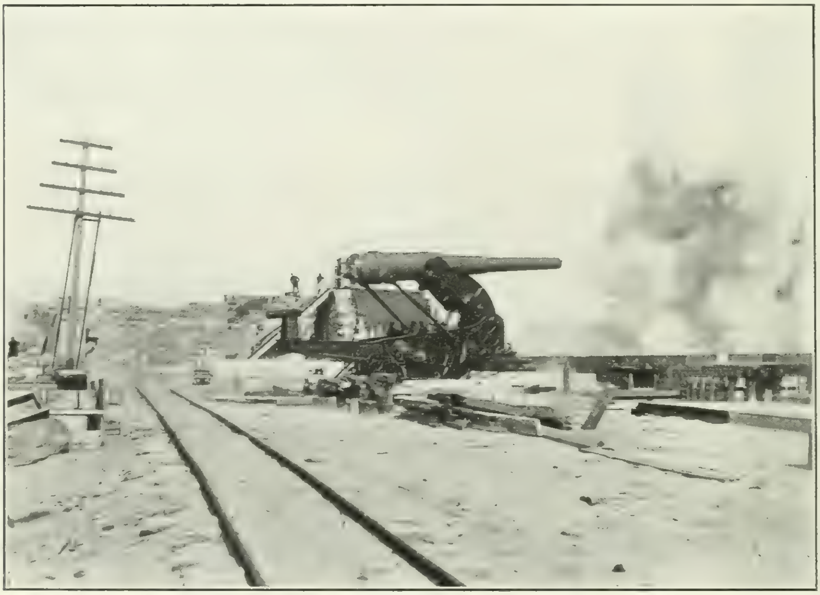


Gordon 10in Carriage.

There yet remains the Howell carriage, the invention of Admiral Howell of the United States navy, but as this carriage is still undergoing the official tests description of it will not be given.

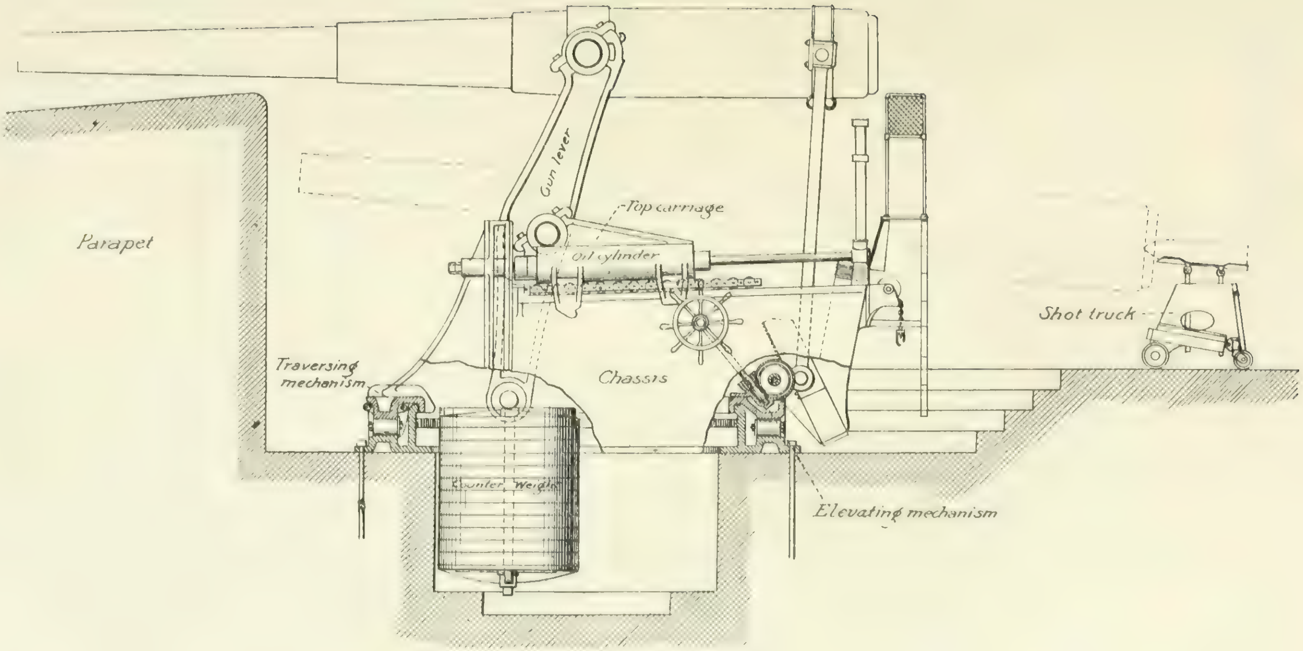
Some years after the abandonment of the King carriage, a design was proposed by the present chief of ordnance of the United States army, Gen. A. R. Buffington, then captain in the ordnance department, and this was later materially modified by Capt. William Crozier of the same corps; but though the Crozier-Buffington disappearing carriage of to-day is based on the original designs of these two officers, it has undergone many modifications and alterations as the result of its actual use in the hands of the troops. The outline sketch will show the general form of the carriage.

Two parallel levers are mounted on a horizontal axis which is trunnioned or journaled in a movable top carriage. The gun is mounted on the upper ends of the levers, and a counterweight is attached to the lower ends. The top carriage carries two oil cylinders and the ends of the piston rods sliding therein are attached to upright brackets at the rear of the main frame or chassis. These oil cylinders are peculiar, in that constant resistance is obtained by the passage of the liquid from front to rear through orifices in the piston head which become smaller as the top carriage moves backward. The cylinders are thus employed to reduce the shock on the stationary parts of the carriage, and they also play an important part in taking up the recoil. In their original form, these cylinders were the main modification by Capt. Crozier of the first designs of this carriage.



UNITED STATES DISAPPEARING-CARRIAGE GUN UNDER TEST AT SANDY HOOK.
The first discharge.

During the recoil the top carriage slides to the rear on the slightly inclined chassis rails and the counterweight rises, while the trunnions



UNITED STATES DISAPPEARING CARRIAGE

Model of 1896.

of the gun describe ellipses in passing to the loading position. The gun is sufficiently over-counterpoised to enable it to return easily to the firing position after being loaded.

The gun is elevated and depressed by means of two arms which are attached at their upper ends to a band near the breech end of the gun, the lower ends being fastened to massive blocks which slide between guides, and the movement of these arms in a vertical direction serves to depress or elevate the muzzle of the piece, as the target may be near or far (see p. 417). The gun is loaded from a truck, which may be seen on the platform at the rear. Guns as usually mounted on this carriage have a field of fire of 120° and a vertical motion from 5° depression to 12° elevation, though a late modification of the design has been made for a 10-inch gun which allows an all-around fire—a condition, however, which is seldom called for in the actual defense of a position.

All the operations of this carriage may be made by hand, but a series of tests are now in progress, with excellent prospects of success, for the application of electric power to the manipulation of the carriage and the service of ammunition, thus saving a material expenditure of "man-power." The supplying of the necessary electric current is a comparatively simple proposition, since all modern fortifications have a complete electric plant for lighting the magazines, operating searchlights, and so on.

The advantage of a mechanical operation of these guns may be better appreciated when the great weights to be moved are considered. A 10-inch gun, for instance, weighs about 67,000 pounds, and the carriage about double as much more, while a single solid-steel shot of the same caliber weighs 575 pounds and requires 250 pounds of powder. A 12-inch gun and carriage is more than double the weight of the 10-inch, and a 12-inch solid shot weighs 1,000 pounds, with a powder charge of 500 pounds. A 12-inch gun detachment consists of 27 men.

These carriages, as installed in the coast fortifications of the United States, have reached a very high degree of perfection in mechanical detail. Whether or not they are best suited to meet the rigorous test of actual warfare is yet to be determined.

EDITORIAL COMMENT

The House of Representatives of the United States Congress, by a vote of nearly seven to one, has declared for the construction of the Nicaragua Canal. An amendment designed to make the bill cover an isthmian canal, leaving the route subject to determination after the investigating commission could hand in its report, was emphatically rejected.

Fortunately, the Senate stands between the United States and a $140,000.000 leap in the dark, and before a basis for concurrent action by both houses is found, the country may be in possession of facts which will determine whether the Nicaragua Canal can be built even for $140,000 000. The jingoes seem to have bristled up against an imaginary foreign opposition to the construction of the waterway, and to have placed the recently passed bill as the proverbial "chip on their shoulder." The forces against which any canal on the Nicaraguan route seems likely most to need "protection," so far as our present knowledge goes, are threefold :

(1) A general drift of the sands along the Gulf coast, which has filled up Greytown harbour in a very few years, and against which no adequate protection seems yet to have been suggested.

(2) The menace of earthquake disturbance sufficient to imperil not only the stability, but the very existence, of a construction so dependent on dams, embankments, locks, and cuttings.

(3) An apparent wide fluctuation in the level of the lake which is to furnish the water supply for the entire canal.

Possibly the President and his advisers may be relieved of serious embarrassment if these factors can be eliminated from the problem before they are called upon broadly "to protect" the canal.

These are fundamental points, and beyond them lie all the serious questions of engineering construction for which no answer is found in any report or study yet presented. An Act of Congress will not establish the canal. Even "patriotism," as it is conceived by the canal advocates, will not replace sound engineering nor common sense and good judgment. Building a canal without knowledge may prove more expensive than building a tower without counting the cost.

* * *

A good deal of comment has been excited by German preparedness at the Paris Exposition, as it appears in contrast with the semi-chaotic condition of most of the space at the opening. Mr. Mitchell, elsewhere in this issue, refers to this as it is displayed in the machinery section ; other observers have reported it more generally. One writer is particularly impressed with the imposing character of the German navigation exhibit, with its "ominous" legend, "*Unsere Zukunft Liegt auf dem Meer*" ("Our Future is on the Sea").

The industrial and mechanical advance of Germany—of which ship-building progress is the most comprehensive expression—is certainly significant, if not "ominous," for the United States and England. Looking back to the marvellous record of the last quarter century, the English-speaking engineering world may well ask seriously as to the future. One thing seems certain—remarkable changes in the distribution of industry, which Mr. John Richards discussed ably in our April issue, are now pending. The total is, of course, vastly greater from year to year, but the foci are shifting. Hardly anyone would have believed, in 1870, that German ship-builders would turn out a Kaiser Wilhelm der Grosse before the end of the century; but now, according to recent reports, the same yards in which she was built are preparing to lay down a vessel far exceeding the Oceanic in size and the Kaiser Wilhelm der Grosse in speed American machine-tool makers are beginning to feel the effects of the great German tool-building establishments. How far is German thoroughness in study and organisation destined to offset her later start and her apparently permanent disadvantages in the matter of iron and steel supply?

* * *

A very intelligent English commentator on American and British characteristics in mechanical manufacture, as they appeared to him after an extended tour throughout the United States, sums up the advantages of the American manufacturer as lying under three headings: "An unlimited supply of cheaper raw material and fuel, and cheaper transport; in many cases better arranged and equipped workshops and more up-to-date tools; and, finally, a higher rate of output from their workmen."

The first point Mr. Jefferies considers "the most serious one for English manufacturers," and most students of the matter will confirm his judgment. He points out, however, that owing to certain conditions, iron and steel are selling at higher prices in the United States than in Great Britain. He does not mention, as a cause contributing to this end, the tariff, which, whatever it may have done to foster "infant industries," is surely no longer needed by the giant iron and steel makers of America, and is becoming a serious handicap to the makers of American manufactures of every kind in their newly awakened essays in the world's markets At present the American manufacturer to whom iron and steel are raw materials is actually at a disadvantage as compared with his European competitor, in spite of the superior richness of his country in iron and fuel deposits. And, furthermore, the furnaces and mills of the United States will sell to all the world—to foreign builders of electrical machinery, engines, or machine tools as cheaply as to home manufacturers—and in the export markets freights will nearly or quite equalise themselves by time the finished goods from the respective sources are at their destination.

As to the second point—equipment—English works are certainly "catching up" at a wonderful rate; and as to the third—higher rate of output from the individual workman—Mr. O'Connell's article in this issue will show how strenuously the American machinist is seeking to commit industrial suicide—or, at least, mayhem upon himself.

* * *

In view of the growing appreciation of the value of standardisation, in connection with every department of engineering work, it is greatly to be hoped that the efforts of the Secretary of the United States Treasury to establish a National Standardising Bureau will be attended with success. The foundations of knowledge are said to lie in definitions, and the foundations of profitable and mutually helpful international trade certainly lie in agreement upon the definitions of those standard measures, weights, units, and physical constants which are the basis of specifications and contract agreements. And it is certainly to be expected that such a bureau, if established, would work in harmony with the similar departments already founded and in operation in England, Germany, Austria, and Russia, with all of which countries the United States have a constantly growing commerce, which will be the direct gainer by the work of the bureau.

The contemplated expenditure is very moderate, being $300,000 for site, building, and equipment, $10,000 for general (presumably annual) expenses, and $34,000 for annual salaries. The amounts annually appropriated for similar purposes by several European Governments are as follows: England, $62,100; Germany, $116 000; Austria, $46,000; Russia, $17,500.

The movement is certainly in line with enlightened effort for international agreement in matters of international engineering interest, and it is to be hoped it will be favourably reported by the Committee on Appropriations and will receive the approval of Congress.

REVIEW OF THE BRITISH PRESS

Workshop Administration.

It is a significant fact in connection with the general transformation which is taking place in works management, that a broader view is beginning to be held regarding the scope and character of shop accounts and workshop administration. This is clearly seen in the paper of Mr. David Cowan, recently presented before the Institution of Engineers and Shipbuilders in Scotland, upon the subject of workshop administration with special reference to tracking work and promptly ascertaining detailed costs and profits.

Mr. Cowan strikes the keynote of the whole matter when he says that the selling price of the product is determined, not so much by its cost as by competition.

"The prevailing idea regarding shop records is that they are only necessary for determining the selling price of the product. The accountant and his needs for arriving at the final results are considered all important, and it is held that any clerical labour over and above is needless. The important functions of records in pointing out where economies may be effected, production quickened, and supplies regulated, are usually lost sight of; and the practical officials are depended upon for the performance of those functions which ought not properly to devolve upon them in detail."

In other words, the shop records should form an efficient guide in showing how and where to meet competition. It is not enough to ascertain how much a product costs, it ought to be shown in what manner this cost is subdivided, how it has been incurred and how its details compare with former identical products. In this way only can intelligent action be taken to reduce costs, and consequently to meet competition.

Mr. Cowan proceeds to describe in detail a general method of cost-keeping based upon the shop-order system, showing the manner in which the orders are originated and transmitted through the works prior to their ultimate classification and record, and emphasises the advantages of the card system over that of bound books for this purpose. A general chart of the system is given, as well as examples of the individual forms, and the whole is discussed at greater length than can here be given. Such a system necessarily requires modification to adapt it to the peculiar requirements of each establishment, and hence it is the principle, rather than the concrete example, which is most important.

The really interesting portion of Mr. Cowan's paper lies in the manner in which it reveals the necessity for the advocacy of what might have been supposed to be an obvious necessity long ago. Apparently it is only when the pressure of competition has brought the matter home to the works managers of Great Britain that they have thought it necessary to give it serious attention.

"In many of the older shops little attention has been given to matters outside the accommodation which may be described as purely productive. General office accommodations, store rooms, work office, etc., have been looked upon more or less as luxuries and sources of unnecessary expense. Proprietors have ever before them the weekly outlay in wages paid to all kinds of indirect producers, but it is only with difficulty that they can realise the losses arising from waste and leakage. They are particularly careful in the handling of actual cash. They do not object to a bookkeeper spending days or weeks looking for an error of a few pence in his balance, but they are not equally alive to the necessity for supervising other items which just as really represent cash. We are now wakening up to the necessity of eliminating waste in every form."

It is not enough to wake up to the necessity for keeping a detailed account of costs; it is also necessary to maintain an accurate record of other details of shop administration.

As Mr. Cowan rightly says, this is a matter which cannot originate with a manager on his own responsibility; it must emanate from the principal, who must thoroughly realise its importance. Even then it will be found a difficult task to introduce modern methods of shop accounting into an old-established shop.

"The old hands who have honestly and conscientiously toiled to build up a business in its early stages under a 'leading-hand' and 'head-of-department' system, which permits of the operation of independent control subject to little or no itemised criticism, are at the outset likely to resent the recording and examination of their individual acts. The march of events will, however, force compliance with the inevitable, and so will arise the necessity for bringing forward a class of men trained in the general principles of administration, and in the scientific and technical principles of design and construction."

A knowledge of the facts, however, will not save the old-established works from the disastrous effects of successful competition, and the best system of accounting is but a means to an end. Behind it must be the intelligence to perceive the meaning of the collected and classified information, and with this must be the capacity to plan improved methods, and determined energy to carry them out. The manufacturer who expects a new system of cost-keeping to reorganise his business and bring profits out of losses will be sadly disappointed if he leans on what will prove to be a broken reed. It is he himself who must have the courage and determination to install and execute the reforms which the best system can only reveal and indicate, and it is to this that the proprietor and manager must awaken.

American Competition.

Notwithstanding the quantity of matter which has been written upon the subject of the competition of the United States with the industries of Great Britain there appears to be room for further discussion of the matter. A recent editorial in the *Engineer,* in discussing a series of articles in the *Times,* brings out some points which are worthy of comment, as bearing upon the main question.

There is no doubt as to the magnitude and importance of American enterprise. The resources of the country and the energy of the people are admitted facts; the question is as to the influence of British industries. Here we meet at once the fact that we must consider not alone the producing powers of one nation, but the buying powers of several.

"It is a fundamental principle of political economy that no one country can prosper as the result of manufacturing effort unless some other country prospers also, because prosperity depends on volume of trade, and trade consists in the interchange of commodities." When, however, three or more countries are concerned, one must be left out in the cold. It is the American invasion of England's foreign markets which is to be considered.

"At the present time the United States is probably the only self-supporting domain on the face of the earth, but the demands for home supply are such as to render it probable that for many years to come the people of the great transatlantic nation will consume so much of their own products that comparatively little will be left for export.

"When, however, the home demand falls off, there must be a sharp and powerful competition with England in her foreign markets, for which she would do well to prepare.

"If, for example in detail, 60 per cent. ore can be dug out of the side of a hill by steam shovels, lifting 5 tons at a time, and put into 25-ton wagons at a cost of 8d. per ton, what chance has the English or Scotch or Welsh ironmaster, who has to import his ore from Spain and pay from 14s. to 20s. a ton for it?"

It is against such competition that the manufacturers of England must prepare themselves to fight. "Ostensibly American competition ought to have brought financial ruin on this country long since. The fact that we are enjoying unprecedented prosperity seems to indicate that after all there are conditions at work which save us, and which are neither fully understood nor appreciated at their proper value. The operation of these factors has been strangely overlooked. England never is, but always is to be, ruined by foreign competition. The pessimist tells us that present prosperity is all very well, 'but wait for a year or so.' We have heard all this said with impressive if monotonous regularity for over thirty years, and still the sword has not fallen."

Nevertheless it is important to study the methods of American competitors and, apart from the advantages of cheap raw materials, ascertain the sources of their operative successes. The advantage of repetitive methods, of automatic machinery, of the specialisation of industries, all these have to be considered. Then, too, the importance of correct systems of works organisation, of accurate cost-keeping and distribution of expense, indicating where economies may be effected and costs reduced, must be appreciated. The study of modern methods in all lines of work, the result of advanced technical education, is an element for consideration, this especially being one of the sources of Germany's strength in competition.

Now, while the possible future effects of American and other competition are realised, and while prosperity at home renders preparation possible and practicable, every effort should be made to meet the impending situation.

"If the people of this country take the proper precautions they will not suffer; what these are has been stated over and over again. There is nothing new to be said on the subject. There is danger in American competition, but no imminent or enormous danger. Great Britain has far more to fear just now from her own people than she has from those of the United States."

Submarine Boats.

A RECENT editorial in *Engineering* discusses the merits and failings of submarine boats in a very interesting manner, and since this important question is treated from an American standpoint elsewhere in this issue, the British view point is a fitting subject for review.

In France it is reported that a fleet of 100 submarine boats has been ordered by the government, while in the United States the Holland boat has been purchased by the government, after exhaustive and critical trials.

The article in *Engineering* is mainly devoted to an indication of the peculiar difficulties involved in submarine boat construction and operation, and these are doubtless many and great. Reviewing the experimental work in this line since the partially successful experiments of Fulton in 1801, the defects in all the subsequent devices are shown, and the drawbacks which must attend the use of even the partially successful boats of the present time.

"The flooded boats, which keep awash, just under the water surface, look like torpedo boats. They are spacious enough not to need any compressed air stores for breathing; and the tube projecting above the water level, provided with a mirror at an angle of 45 deg., is a help to the man at the helm—not much of a help, though, for the elevation is too small to give a proper field of view. In stability these craft are superior to the totally submerged boats, but they suffer from many of the drawbacks of submarine boats which are regarded as serious, notably by such an expert as Professor Busley. He is acting President of the newly-formed Schiffbautechnische Gesellschaft, a German naval constructors' institution, whose inauguration recently was attended with so much *éclat,* due to the presence of the German Emperor to hear the Professor's contribution on this important subject of submarine boats.

"Amongst those serious inherent difficulties, Professor Busley places first the low stability of submarine boats. Some people still seem to forget that the displacement centre of gravity of a totally submerged boat is simply the mass centre of the water displaced, and does not alter its position, whatever inclination the boat may assume. There is no buoyancy. Yet transverse stability and prevention of rolling is not so difficult to obtain, provided the section of the boat is like that of an egg, poised on its point. If we use ballast, the centre of gravity of the system will be low down, and the displacement centre high up. The low longitudinal stability, the tendency to pitching, is the trouble. A man need only step forward to send the nose of the boat down. For this reason the Plongeur of Bourgois failed, and the length of boats has been reduced again. Goubet has gone furthest in this direction, and his two men always sit in the middle of the boat. Bauer tried to apply counterpoises, Holland automatic pumps, to restore longitudinal equilibrium. Nordenfelt did not deprive his boat of all buoyancy, and counteracted its effect by a submerging propeller. The flooded boats are better off in this respect. But even in their case we notice a reduction in length; the Zédé had a length of 45 metres, the Morse of 36 metres, the Narval of 34 metres. It has, on the other hand, been pointed out that they are not good sea-going boats, hardly fit for rough weather; and their own designers have proposed to give them a little freeboard. If we do that, we lose the chief advantage of the submarine boat, the immunity against projectiles; and we may argue whether we had not better return to ordinary boats, in which we are not tied down to small space and small speed, and all sorts of undesirable conditions.

"Submarine boats remain dangerous to manage. On the average, perhaps, we may construct them strong enough to descend to a depth of 100 ft. Supposing a boat, moving at the usual speed under water, 8 knots, is to discharge a torpedo. Two men are sent forward; the boat at once inclines 15 deg., and within half a minute it will have arrived in its critical depth. If there is any delay or any fault in the steering gear or in the application of safety weights, etc., every second will seriously increase the pressure of the water outside. Trials made with the Gymnote, moreover, indicate that submarine boats do not obey their horizontal helms with sufficient rapidity. The Gymnote always overshot her mark, and would not keep on a straight course, but described a succession of curves. Professor Busley tried to pull a submarine boat under water; it could not be done when the speed exceeded 4 knots. That all operations near the coast or in shallow water are exceedingly dangerous, need not be emphasised."

While all these difficulties doubtless exist, they are not unsurmountable, and the trials of the Holland boat show that to a certain extent, at least, they have been overcome. It will not do to sit still and argue about the difficulties of making and operating submarine boats, while other nations against which Great Britain may suddenly be called to contend are patiently working to solve the problem. The greatest battleship afloat may succumb without a blow to the insidious stroke of the submarine enemy, while any harbour protected by such invisible defenders may consider itself practically safe. If these possibilities are involved in the possession of successful submarine boats England should bestir herself to learn by practical construction and test just how far such possibilities may become stern realities.

The Development of Germany.

Although the continual advance of Germany in the commercial, economic, and technical worlds has been known in many quarters it has remained for the valuable report of Mr. Gastrell, the commercial attaché to the Embassy at Berlin, to place the facts before the English-speaking public in a condensed and comprehensive manner. The position of Germany, as a powerful and united territorial nation, was initiated in 1871, since when its strength has rapidly grown year by year in every direction.

"The German Empire, as a Continental great Power, has now far surpassed the expectations of its founders thirty years ago. Who can say how far the next three decades may not fulfil the present national aspirations of becoming a future "world power"; by which is meant the acquisition of the status of a great naval and colonial Power in the whole world in addition to the position of the leading territorial great Power, already obtained in Europe? 'Imperial unity,' was the cry of 1871. 'Imperial expansion' is the watchword of 1900.

"In industrial and commercial matters, the first 20 years of the existence of the German empire, from 1871 to 1890, were devoted to the elementary education of its people; the following 10 years, 1891 to 1900, have been spent on their higher education, and the twentieth century sees in them a body of men, each an expert in his own trade or profession."

Since the prosperity of Germany depends primarily upon its trade, and secondly upon its agricultural resources, it follows that the growth of German power can best be gauged by an examination of the state of the national industries, followed by a view of the condition of the landed interests. Mr. Gatchell gives very complete statistical data concerning the development of German industries, from which some valuable general conclusions may be drawn.

The population of the German empire is now about 56,000,000, having increased by 15,000,000 since 1871, but while emigration has very greatly diminished the demand for labour can hardly be supplied. In view of the possibilities of future economic expansion, it is well to note that in the three leading industrial countries of Europe the yearly increase of the population accruing from the excess of births over deaths is, approximately 850,000 in Germany, 450,000 in the United Kingdom, and only 35,000 in France.

The data for comparisons of commerce in various years are given in detail, for which the original report must be examined; it is sufficient to note that in 1872 the imports amounted to £163,000,000, and the exports to £116,000,000, while for 1899 the imports reached a value of £259,850,500, and the exports £166,000,000. In this connection it is important to note that the quantity and value of the imported raw materials for local manufacture are yearly increasing, and that, at the same time, the quantity and value of exported manufactured articles is also steadily rising from year to year.

The extraordinary growth of German maritime interests also bears witness to the development of national prosperity. A recent official calculation states that at least 70 per cent. of all German commerce is now carried by sea. In actual tonnage German shipping now stands second in the world, with 1,594,596 tons, and its steam tonnage in 1899 was about 10 times as great as that of 1872. During the last 25 years the relative proportion of the mercantile marine of Germany to that of the whole world has risen from about 5 to more than 8 per cent.

The development of the various states constituting the German empire is given in detail in the report, and a view of the progress in Prussia may be taken as typical of the others.

The total revenue of Prussia was £33,250,000 in 1872, and is estimated at £119,987,185 for 1900, an increase of about 210 per cent. It is true that the public debt has increased from £64,363,000 in 1872 to £329,584,000 in 1900, but it should be remembered that this large debt was almost entirely contracted for the purchase of the State railways, which form by far the most important of the paying properties of the Prussian State. This should therefore be looked upon as an investment, and not as an unremunerative debt in the ordinary sense.

One of the most important branches of State expenditure, so far as technical progress is concerned, is that which has been made for education, and especially technical education. In 1871 only £15,000 was spent on industrial schools, while the estimates for 1900 allow a sum of £281,000 for this object. "It will thus be seen that the Prussian government has devoted great care to the important question of education, especially in the matter of technical and commercial education. As regards the latter, for instance, the receipts in 1890 were £2,500, and the expenditure £93,000, as compared with £30,000 and £195,000 respectively, in 1897. And, during the same interval the total number of State schools of engineering and architecture rose from 1 to 13, and that of schools for machinery and mining, etc., from 1 to 7."

These are a few of the bare facts, but the real purport of the development of Germany is seen by everyone in the manner in which she has invaded the markets of Britain everywhere. "Made in Germany" is no longer a warning or a reproach. *"Billig und schlecht"* has been replaced by *"Billig und gut,"* and the German flag is seen in every port. This advance is the result of no sudden spurt, it is the consequence of the steady development of nearly a generation, a development, the foundations of which were laid by Prince Bismarck, and the superstructure reared by his successors.

How England can best meet this competition remains to be seen. Certainly not by ignoring it, nor yet by evidence of distrust in her own capacity. Anglo-Saxon determination, backed by the resources and prestige of generations of commercial and technical supremacy, must be fully equal to the task, but the magnitude of the task must be appreciated in order that it may be successfully accomplished.

The Electrical Equipment of War Ships.

THE use of electricity for the transmission of power to the various parts of a vessel has been an attractive problem for several years past, especially since the general introduction of electric lighting has rendered the installation of some kind of a generating plant a necessity.

This whole matter of the electrical equipment of war ships forms the subject of an exhaustive paper recently presented before the Institution of Electrical Engineers by Mr. C. E. Grove, from which some extracts are here reviewed.

The author especially disclaims the intention of discussing administrative and tactical questions, treating the subject solely from the point of view of the independent electrical engineer.

Naturally much of the work which has already been done has been in British war ships and in ships built in England for foreign governments, and Mr. Grove devotes the first part of his paper to a description of some of the existing installations on British vessels.

One of the earliest applications of electricity on shipboard was that of lighting, and in his paper Mr. Grove discusses the growth of electric lighting for naval use, including incandescent lights for general purposes, signal lights for use at sea and at anchor, and search lights for special service, and compares the practice of various countries in connection with this important branch of the service.

The principal differences between lighting on shipboard and on land lie in the methods of running the cables and providing accessibility to all parts, while at the same time avoiding the weakening of water-tight bulkheads. Various methods have been employed, including the use of iron or wooden conduits, but the British Admiralty system of lead covered cables, closely packed together, and visible and accessible throughout their whole length, is greatly to be preferred to any method in which the wires are concealed.

It is, however, for power transmission, replacing steam or hydraulic auxiliaries, that electricity is at present chiefly attracting attention. This phase of the subject is discussed at length by Mr. Grove, and the gradual displacement of steam by electricity is a matter of comment. Until a few years ago the whole of the auxiliaries were steam-driven, with the exception of the gun-working machines, for which hydraulic power was preferred. By degrees electric driving has been applied to one and another, the most advanced example being the U. S. battle ship "Kearsarge," just completed, which carries 55 motors and a generating plant of 350-kilowatt capacity. Much of the discussion relating to the advisability of replacing steam auxiliaries by electric driving is due to a realisation of the wastefulness of the small steam engines used for the various auxiliary machines, and at the present time it is still an open question whether or not the steam auxiliaries can be so improved in economy as to maintain their supremacy.

Mr. Grove examines the important paper of Passed Asst. Engr. W. W. White, U. S. N., upon the tests of the auxiliaries of the American cruiser Minneapolis, and also the recent papers of Lieut. J. K. Robison, U. S. N., in THE ENGINEERING MAGAZINE for October and November, 1899.

Mr. Grove takes issue with Lieut. Robison in his contention that the excessive weight of motors for electric driving would be objectionable, and maintains that with properly designed and selected motors the advantage is distinctly on the side of electric driving. The service is not more severe than that demanded by tramway motors, and the conditions should be as readily fulfilled.

Smoke Prevention and Public Health.

IN the recent issue of the *Journal of the Sanitary Institute* there are two papers dealing with the question of smoke prevention from the view-point of the effect upon public health, which demand attention as falling within the province of the engineer. A paper by Mr. E. A. Brayley Hodgetts opens by the positive statement that "smoke is a preventable nuisance, a danger to health, a national waste, and that it should therefore be prohibited." This is strong language, but not altogether unjustified. All life depends upon the light and heat of the sun, but "it has been reserved for so-called civilised peoples to produce artificially and at great cost, clouds composed of sulphurous vapours and small particles of carbon to hide the sun from them, and cover the places where they live with a pall which keeps out the light, arrests vegetation and interferes with the functions of the respiratory organs."

The pollution of the air by smoke is as

injurious as, or even more injurious than, pollution of air or water by sewage or natural impurities, since the latter but breed epidemics which reveal their origin and can be combatted, while the wholesale poisoning of the air by coal products, and the consequent obscuration of the sun and absorption of oxygen, is a direct danger to every individual, and if permitted to go far enough would doubtless result in the final extinction of the human race. The influence of smoke upon public health is shown in the fact that there is no record of smoke-producing towns keeping up a natural increase in the population, the increase in the population of cities being maintained at the expense of the country.

Mr. Hodgetts does not go into the question of methods of smoke prevention, confining himself rather to the necessity of education of the public as to the danger of smoke pollution, urging also an impartial enforcement of the law upon rich and poor alike.

The second paper, by Dr. Joseph Priestley, is hardly as radical as that of Mr. Hodgetts, since, while affirming the injurious effects of coal smoke, he admits that a certain amount of it is not preventable.

After reviewing the legislation which has been made concerning the regulation of smoke production, Dr. Priestley shows that the matter legally hinges upon two points; namely, the degree of intensity which constitutes *black* smoke, and as to what constitutes reasonable precaution against the production of black smoke. As at present construed the production of black smoke renders the producer liable to fine, notwithstanding the fact that the furnaces may have been fitted with the most improved appliances for smoke prevention and the smoke may have appeared for but a few minutes. Since Dr. Priestley is of the opinion that the practically perfect smoke-prevention appliance has yet to be introduced, such an enforcement of the law appears to him to savour of persecution.

"All smoke cannot be prevented except by shutting down all factory and workshop fires; and recognising the difficulty of consuming smoke when once formed, it follows that prevention is better than cure, and such prevention consists in frequent and careful light stokings, with or without mechanical appliances, and the use of suitable fuel—sufficient boiler power being, of course, a *sine qua non.*"

It must not be forgotten that the degree of blackness of smoke indicates only the quantity of solid carbon present, and that a very small amount of solid carbon is sufficient to produce a high degree of opaqueness. The injurious sulphurous gases are themselves nearly or quite colourless, but at the same time the blackness of the smoke is a fair indication of the degree of imperfection of the combustion, and hence of the production of deleterious gases. Anything, therefore, which reduces the blackness of the smoke may be considered as an improvement in the combustion, and consequently much to be desired.

The whole subject is one which should be considered from the two standpoints of public health and industrial prosperity. It is now generally conceded that smoke prevention does not necessarily mean fuel economy, and that manufacturers cannot expect to realise any great saving by preventing the production of smoke. The matter must rest upon the degree to which manufacturers should be prevented from polluting the air we breathe, as they are now generally prevented from polluting the water we drink.

The Breakage of Propeller Shafts.

Among the papers presented at the recent meeting of the Institution of Naval Architects, one of the most important was that by Mr. A. Scott Younger upon the corrosion and failure of propeller shafts.

The increasing frequency of shaft breakages is a matter of common knowledge among marine engineers. During the period between the months of January and July, 1899, eighty-three casualties occurred to shafts and propellers of classed vessels, and of these only 10 per cent. were due to accidents to propellers. Of the remainder, the accidents to propeller shafts were 50 per cent. more numerous than those to all other kinds of shafting together. This applies only to British vessels, and according to another reliable authority, there were during 1899 nearly 250 cases of accidents to the shafting and propellers of steamers of all nationalities.

Mr. Younger starts out by stating that

his object is to account for the extreme corrosion which occurs at the ends of the brass liners on tail-end shafts, this being one of the commonest causes of shaft breakage. The general arrangement of a tail shaft is with two bearings, sheathed with brass or gun-metal liners, and corrosion of the shaft is found to occur at the inner end of the outer liner and the outer end of the inner liner, breakages frequently occurring at one or the other of these points.

"While all writers are agreed that corrosion occurs just at the ends of the liners, there is not the same agreement among them as to the cause. It has been said by some to be wholly due to galvanic action. Others say that the corrosion is due to galvanic action plus the vibration and shock set up by the propeller in striking the water. Others again have adopted the theory that the water at the ends of the liners has a sawing action which gradually wears away the shaft."

Mr. Younger gives a detailed examination of the stresses produced in a shaft in a typical case, using a graphical method for ascertaining the bending movement at various points in the shaft. Although the bending movements thus deduced are not excessive, yet it must be remembered that the first business of the shaft is to transmit a twisting movement, and that the bending movement is subsidiary; hence these stresses become of extreme importance.

In order to give the theory a practical trial, Mr. Younger constructed a series of model shafts, which were placed in a lathe and revolved while under the action of bending moments. A careful record was kept of the time required to fracture each shaft. Some of the shafts were straight, of uniform diameter, others were enlarged at the parts passing through the bearings. The results showed that the shafts broke at the points where the diagrams indicated the severest stress, and that the plain shafts showed greater strength, running four to five times as long as the shouldered shafts. There appears to be no doubt whatever that any sudden change in the cross-section of a shaft is an element of weakness, even when the change is an increase in diameter. A number of devices have been made to provide a suitable and effective stern-tube fitting without the use of liners, some of these being illustrated in Mr. Younger's paper.

The general conclusions drawn in the paper are that there are three methods in which the question of the prevention of shaft breakages may be treated. The first is to increase the diameter of the shaft to a point where the stresses arising from the bending action become negligible. In most cases this would involve an increase of about 15 per cent. in diameter, although the weight of the propeller and the speed of the ship would have to be taken into account.

The second method consists in reducing the bending moment on the shaft, either by the use of an outer bearing, by a reduction in the weight of the propeller, or by an increased quantity of water ballast to insure a deeper immersion of the propeller.

The third and last method is to arrange the material in such a way that the section of the shaft is continuous, thus doing away with the localising of the stresses at particular points. The only satisfactory way to do this is to abolish the liners altogether, and then fill the stern tube with tallow or oil to prevent the bearings from rusting.

The general opinion in the discussion of Mr. Younger's paper was that stronger shafts were a necessity. Propellers have been growing heavier all the time, larger diameters being used than formerly, and larger diameter shafts should follow.

The question of the immersion of the propeller is also a very important factor in shaft breakages. The practice of sending vessels to sea with the hub of the propeller awash is doubtless responsible for many tail-shaft breakages. It was suggested that there should be a minimum as well as a maximum load-line, and that a ship should not be permitted to go to sea unless her propeller was immersed.

Stern-post bearings are not likely to come into use, and would prove of more harm than good if they were used. The action of the rudder will deflect the post and throw additional stresses on the shaft, increasing the liability to breakage. The true remedy is to provide sufficient strength in the shaft to resist all the stresses which are liable to come upon it, and the increased cost involved in doing this will prove economy in the end.

REVIEW OF THE CONTINENTAL PRESS

Power Used in Machine Tools.

During the past few years considerable attention has been given to the operation of machine tools by electric motors, and the principal advantages of this system are well recognized. There is no power consumed by long lines of shafting, there are no small steam engines with low efficiency, each tool is supplied with just the power it needs, and when idle wastes no energy.

Under the older systems there is generally only a vague notion of the power needed to drive a machine under various conditions, but with an electric motor this difficulty disappears, for it is possible at any instant to measure exactly the energy used by the motor. Some experiments at the Atlas Works, Sheffield, were reviewed from the *Engineer* in our May issue, and in a recent number of *Glaser's Annalen,* Herr Loch gives some interesting statistics of the main railway shop at Gleiwitz.

In this shop there are 107 electric motors of various sizes used for running tools and other machines. When the machines were bought it was found that the makers themselves were generally ignorant of the power required to run them, and so there were some mistakes made in choosing suitable motors, some being too weak and some too strong for the work they were called upon to perform. When overloaded, the motors heat up very much and often stand in need of repairs; and it is not sufficient for them to be able to carry the ordinary loads, but they must also be able to bear the extra loads at the starting of the machines. The current used at starting is from one and a half to three times that required under normal conditions, the added amount depending partly upon the masses to be set in motion and partly upon the care with which the starting resistances are switched in. Motors which are larger than necessary have no drawbacks except the enhanced first cost, as their efficiency falls off but little when not fully loaded.

A great many measurements were taken at Gleiwitz to determine the proper size of motor to run the various machines, and there is a list of fifty-seven tools, with their corresponding motors, in the original article, to which the reader is referred.

Among other results, it was found that a planer with a working surface 300 x 100 centimeters needed a 5-horse-power motor, while another one, 160 x 85 centimeters, took 3 horse-power. A shaping machine, with a 30 to 40 centimeter stroke, used 2 horse-power, the same as a circular saw 50 centimeters in diameter, while small and medium lathes required 1 to 2 horse-power. A horizontal milling machine was satisfied with 1 horse-power, borers and drills of various styles and sizes needed from 1 to 6 horse-power, emery wheels, 2 to 4 horse-power.

The electrical measuring instruments give an exact account of the power consumed at every stage of the operations. The machines can be observed at starting, when running unloaded, at various speeds and under all conditions, and it is frequently found that the useful work done requires only a fraction of the total power consumed by the machine. By comparing the power consumption of similar machines when unloaded, one can draw interesting conclusions as to their condition, the care with which they are maintained, and the suitability of their construction. The no-load power consumption of car-wheel lathes of different makes varies, for instance, from .63 to 1.9 kilowatts.

The reversal of the motion or the quick back-stroke of the working parts often demands the greatest outlay of energy, in the wood-planing machines, for instance, requiring more than the working stroke.

The influence of different speeds on the power consumption is shown by the following example: A shaping machine required 1.7 to 2.3 kilowatts at starting. When running empty it used:

At 10 strokes per minute and 18 centimetres length of stroke, .46 kilowatts.

At 16 strokes per minute and 18 centimeters length of stroke, .53 kilowatts.

At 24 strokes per minute and 18 centimeters length of stroke, .59 kilowatts.

At 38 strokes per minute and 18 centimeters length of stroke, .85 kilowatts.

At 38 strokes per minute and 10.5 centimeters length of stroke, .63 kilowatts.

At 38 strokes per minute and 30.9 centimeters length of stroke, 1.38 kilowatts.

When working with a 4-millimeter cut, at 16 strokes per minute and 18 centimeters length of stroke, only 0.85 kilowatts was consumed.

There are also given results with various other machines, which can only be referred to here.

The 107 motors in the main shop have a combined output of 334.5 horse-power, and require 331 kilowatts at their terminals, or 347 kilowatts, including the loss in the conductors leading to them. If all the motors had been made large enough for their work, they would have had an output of 454 horse-power, and the corresponding consumption of energy would have been 426 kilowatts, or 461 kilowatts including the line drop.

When running under normal conditions, the motors use, on an average, from 250 to 450 ampères, at 220 volts—that is, from 55 to 99 kilowatts, including the conductor losses. The total energy consumed per month is about 15,000 to 20,000 kilowatt-hours. From these figures it follows that the average load of all the 107 motors is only from 16 to 29 per cent. of their normal capacity.

The Physics of the Coherer.

THE coherer—the essential part of the receiving apparatus in space telegraphy—operates in accordance with the well-known fact that its conductivity is altered when electric waves strike it. With the substances in ordinary use for coherer filings, the conductivity is increased by the impact of the ether waves, and though the exact nature of this increase is unknown, it is generally believed to be ultimately due to some molecular or atomic changes.

Experiments recently made by Joh. Härdén, and described by him in the *Elektrotechnische Zeitschrift,* seem to show that before we reach the ultimate explanation, there is a simple mechanical one, adequate as far as it goes. Herr Härdén made a microscopic examination of the action of the coherer, and in order to do this effectually, he discarded the ordinary tube filled with filings, and used two finely pointed steel wires instead. These were placed in circuit with a galvanometer and a small battery. The points of the wires were situated in the field of the microscope and the distance between them was regulated by means of a micrometer screw. The transmitting apparatus was placed in the focus of a parabolic reflector, so as to concentrate the issuing waves on the receiver. Under the influence of these waves, sparks began to pass between the steel points of the "coherer" when separated by a distance of 0.3 millimeter, but the galvanometer showed no deflection. As the points were brought closer together, the sparking grew more active, until, when they were 0.006 millimeter apart, a distinct, dark bridge was suddenly formed between them. With a magnifying power of 300 diameters it could easily be seen how small metallic particles were torn from one point and carried over to the other while the sparks were passing. At the instant when the bridge was formed, all sparking ceased, and the galvanometer showed a deflection corresponding to about 150 milli-ampères. This deflection remained pretty constant as long as the bridge lasted; it changed by a few scale divisions when stronger impulses were sent out by the transmitter.

As soon, however, as the steel points were lightly shaken, the bridge between them was destroyed, and the galvanometer needle went back to zero. The whole process was repeated whenever new electric waves struck the coherer, and in every case the galvanometer deflection was about the same.

These experiments furnish pretty conclusive proof that the little sparks excited by the impact of the electric waves carry over minute metallic particles from one point to the other, and when the distance is not too great these particles form a bridge, which is then used by the battery current. The experiments also showed that in working coherers it is of particular importance to have the breaks between adjacent points or filings as small as possible, for otherwise no bridges can be formed.

One of the greatest faults of coherers has been their unreliability. A coherer will work very satisfactorily for a while, and then, without any apparent reason, it will work very badly or even not at all.

In order to overcome this defect, an arrangement which gave very good results was tried in the course of some wireless-telegraphy experiments near Brest. As described by M. C. Tissot, in a note in the *Comptes Rendus,* the modification in the receiving apparatus consisted simply in placing the coherer in a magnetic field with the lines of force parallel to the axis of the tube. The filings in the tube must be of some magnetic substance—steel of different kinds, nickel, or cobalt. The electrodes may be either of a magnetic or of a non-magnetic metal. The general results are about the same, whatever be the means resorted to for creating the magnetic field. For instance, the electrodes themselves may be of steel feebly magnetised, or they may be of soft iron surrounded by a coil of wire, or a separate permanent magnet may be used.

A convenient method for observation is to use non-magnetic electrodes and to place the entire tube between the pole pieces of an electromagnet, feebly excited.

By this means it is possible to increase greatly the distance between the electrodes without lessening the sensitiveness of the coherer. In ordinary tubes, the electrodes are from 0.5 millimeter to 1 millimeter apart, but when placed in a weak magnetic field, this distance can be increased to 6 or 8 millimeters without diminishing the sensitiveness. The most valuable effect of the magnetic field, however, is to keep the sensitiveness constant, so that the coherer will work with steady reliability.

Commerce Destroyers.

In navies, as in other earthly things, fashions change from time to time, and whereas there was a boom in commerce destroyers a few years ago, nowadays heavily armoured vessels are all the rage. There is one peculiarity about naval fashions, though, which is that as it takes a couple of years to build and equip a modern man-of-war, a ship may be out of fashion by the time it is ready for service.

This seems to be the case with two new French vessels, the Guichen and the Chateaurenault, which were begun while the "corsair cruiser" fashion was on, but which are now severely criticised, although it is acknowledged that they are very good examples of their type. It is the type which at present is thought to be at fault, and in the French naval programme recently issued there is no provision made for any unprotected or even lightly protected cruisers.

According to *Le Yacht,* the Guichen and Chateaurenault are vessels of a little more than 8,000-tons displacement. Each carries a rapid-fire battery consisting of two 16.47 centimeter, six 13.86 centimeter and ten 4.7 centimeter guns. The hulls are unarmoured, but there is a protective deck and light armour about the 13.86 centimeter battery. The Guichen has shown a speed of 23.55 knots on her official trial trip off Toulon, and it is confidently expected that her sister ship will reach at least the 23 knots required by the contract with her builders.

But it is claimed that these ships cannot maintain this speed in active service, and that they will never be able to overhaul the first-class ocean liners. It is pointed out that the Columbia, which did 22.8 knots on her trial trip, could make only an average of 18.16 knots on her homeward voyage from England, whereas many of the merchant greyhounds average more than 20 knots, year in and year out, while the best of them already go above 22 knots in every-day service.

The commerce-destroying activity of these naval corsairs will then be confined to the slower passenger boats and the freight vessels. But it is said that this work can be done just as well by ships which, if a little slower, are able to give and take hard blows and can defend themselves when they meet an enemy.

All the great maritime nations now have fleets of subsidised merchant vessels which in time of war can be armed and converted into auxiliary cruisers. It is thought that some of these ships would be able to give cruisers of the Guichen class a pretty stiff fight and might even beat the commerce destroyer. When warships have no strong points except their speed, they become antiquated in a short time. The fast cruisers of a dozen years ago could hardly escape from a battleship of the latest type, and a commerce destroyer than can neither catch its prey nor run from its enemies is in a pretty bad way.

At present the fast armoured cruiser is considered to be the type that combines the greatest number of advantages. A 23-knot vessel like the Jeanne d'Arc, for instance, can prey upon the enemy's commerce, can beat protected cruisers, can bombard shore batteries without great risk, and can even measure her strength with battleships. It is true that the cost of such a great cruiser is enormous, but in this case, as in many others, it is probable that the best will prove to be the cheapest in the end.

The Trans-Sahara Railway.

In the partition of Africa, France has acquired an enormous district, which differs from the British and German spheres of influence in being much more compact. It stretches from the Mediterranean on the north to the Congo River on the south, from the Egyptian Soudan on the east to the Atlantic on the west, and with the exception of Morocco and the British and German possessions on the Gulf of Guinea, almost all the territory included within these wide limits is under the dominion of France.

On the northern edge of this area are Algiers and Tunis, on the western and southern, Senegal, French Guinea, the Ivory Coast, Dahomey and French Congo, while the interior of this vast region is divided into two parts: the Sahara, to the south of Algiers, and the Soudan, between the Sahara and the equator.

It was long believed that the Sahara was a frightful desert, void of all animal and vegetable life, and that, on the contrary, the Soudan was a marvellous country, of unexampled fertility; but the reports of travellers who have visited these regions have given us juster ideas concerning them.

The Sahara, it is true, has arid regions, bare plateaus and sandy mountains, but it also contains many cultivated and inhabited oases, where the date-palm flourishes, and it is reasonably certain that with the aid of artesian wells these fertile areas can be largely increased.

The reports about the Soudan are less concordant. It is known that districts about the upper Niger and the upper Senegal are rather poor, while the central Soudan between the Niger and Lake Tchad is a fertile country, but there is very little information about the regions bordering Lake Tchad on the north and east.

The war in South Africa, and the recent occupation by the French of In-Salah, a place in the Sahara south of Algiers, have, according to M. G. Leugny, who writes in *La Revue Technique,* aroused fresh interest in a project which of late years has been rather neglected—the Trans-Sahara railroad.

As far back as 1880, some preliminary surveys to the south of Algiers were made by exploring parties, but the disastrous end of the expedition commanded by Colonel Flatters, which was ambushed and nearly exterminated by the Touaregs, put a stop to this work for many years. But now there is renewed interest in the matter, and a Paris newspaper, the *Matin,* is sending out an expedition to complete the work of Flatters.

The southern portions of the French African empire are practically isolated at present, the vast interior regions presenting an almost insurmountable barrier between them and Algiers, so that in case of a war with a strong naval power like England, they would be in great danger. But Algiers is comparatively near France and possesses, moreover, its own means of defence, so that if it and the other parts of French Africa could be firmly knit together by a railroad there would be little to fear from an outside foe.

Besides these strategic reasons in favor of a Trans-Sahara railroad, there are political and economic ones as well. Such a road would bring the different parts of the country into touch with one another and would greatly facilitate their economic conquest.

Algiers possesses a railway system, some of whose branches already touch the confines of the Sahara, and the question now to be decided is: From what point shall the new road take its departure? Biskra, already connected with Philippeville on the

Mediterranean by a line through Constantine, seems to be the place most favored. From here the road would run almost due south to Timassinin and Amguid, about 1,100 kilometres from Philippeville, and on the watershed between the Mediterranean and the Niger. At Amguid the road would divide, the main line going east of south toward Lake Tchad, and a branch running southwest to Bouroum, at the bend of the Niger. As far as the watershed there seem to be but few engineering difficulties. For long stretches there is a grade of only one-tenth of one per cent., and the divide can be crossed at an altitude of 650 metres.

There is but little positive information about the southern slope toward the Niger and Lake Tchad, but for the present most attention will be paid to the northern section of the road as far as Timassinin and Amguid, which are important markets and caravan stations. It is estimated that this section could be completed in two years.

As to the amount of traffic that can be counted on, it is pointed out that the inhabitants of the Sahara get their supplies from Tripoli. Now the cost of transporting a ton of merchandise on camel's back from the latter city to In-Salah, in the Touat region, is from 1,300 to 1,400 francs, and the journey takes from forty-five to fifty days. If the railroad were built, Timassinin could be reached from Philippeville in three or four days, and a ton of freight could be transported for about 60 francs. Freight for In-Salah would have to be forwarded by camel from Timassinin at a total cost of 550 francs by this route, against 1,300 francs for the all-camel line. This difference would necessarily make Timassinin a great center of trade in the Sahara, and, as the road is extended southward it will tap other caravan routes and build up a large import and export business, the total receipts being estimated at 6,265,000 francs per annum.

When the road reaches the Soudan it will make an outlet for the rich products of that region, some of which are ivory, ostrich feathers, gold dust, hides and leather, india rubber, coffee, cocoa, pepper, palm oil, and precious woods.

The length of the main line from Biskra to Lake Tchad will be about 3,100 kilometres, and it is estimated that receipts amounting to 10,000 francs per kilometre, £620 or $3,100 per mile, can be counted upon from the total freight and passenger traffic of the Sahara and the Soudan, while it is claimed that the fixed charges and operating expenses will be only 2,500 francs per kilometer—£155 or $775 per mile.

A New Electro-Graving Process.

Heretofore, the process of etching metals, either chemically or electrolytically, has consisted in covering the parts which were not to be acted upon, and then allowing the chemical or electrolyte to etch the uncovered portions. In this way all the uncovered parts are etched to the same depth, and if we wish to have differences, the process must be repeated, those portions which have reached the desired depth being now protected and the etching agent allowed to act on the remainder.

But it would be almost impossible by this means to make a hard metal die with curved surfaces, and even after many re-coverings and etchings it would be necessary to finish the work by hand.

It has been reserved for Herr Josef Rieder to surmount the difficulties of electro-graving steel by a very ingenious process, which he describes in the *Elektrochemische Zeitschrift*. He uses as an electrolyte an ammonium chloride solution, in which there dips a block of plaster of Paris having a design, in relief, on its upper face. Under the plaster block, in the electrolyte, there is a coil of wire which serves as a cathode. The steel plate which is to be etched rests upon the relief on the upper surface of the plaster, and is connected with the source of current so as to form the anode. Now when the electrolyte has filled the pores of the plaster, it can be said that the steel plate rests upon a liquid surface in relief. It can also be seen that the plaster as a rigid body prevents the pressure of the steel plate from altering this liquid surface, and so the plate and the liquid can be in contact only at the highest point of the relief.

If now the current be allowed to pass, chlorine will be set free at the anode, where it will combine with the iron in the plate, the resulting chloride then dissolving in the electrolyte. At the places where the steel plate touches the plaster it is gradually eaten away and settles down so that more points come into contact with the plaster and electrolyte, the etching thus going on over an increasing area. The first point of contact, corresponding to the highest part of the plaster relief, will be the most deeply etched, and the whole process will be finished as soon as all the points of the etched surface touch the plaster model.

This seems comparatively simple, and so Herr Rieder thought when he began his experiments, but it took three years of continuous labor to reduce his ideas to a practical working basis. His first apparatus was a rough one. He took a block of plaster of Paris with a cast of a coin on its upper surface, saturated it with a ten per cent. solution of ammonium chloride, placed a steel plate on top and turned on the current. But in a short time the first difficulty presented itself. How could the progress of the etching be ascertained? Only by taking off the plate. But if the plate were removed, it would be practically impossible to restore it to exactly the same position it first occupied, and by any inaccuracy in replacement the etching would be spoiled.

He guessed that an hour would be about right, but when he removed the plate, a black pasty substance covered the surface of contact and only after this was cleaned off, could there be distinguished an etching which by a large stretch of imagination might be called the relief of a coin.

In the first place, then, some arrangement had to be made by which the plate could be lifted off the plaster model from time to time and replaced exactly. This was effected by taking a board with a hole in which the block of plaster was exactly fitted, and placing the steel plate in a wooden framework secured to the board.

This difficulty having been removed, further experience soon brought up some other points.

The carbon and other insoluble substances contained in the steel have to be removed from the plate mechanically every little while, as they appear in the form of a powder between the model and the plate and make the fine work impossible. The intervals at which this cleansing has to be done depend largely upon the percentage of carbon in the steel.

At the working surface of the plaster, the chlorine, which is the effective etching agent, is rapidly consumed, and the diffusion from the electrolyte through the pores of the block is not great enough to supply the waste. In consequence it was found necessary, whenever the plate was lifted to remove the carbon, to apply some fresh ammonium chloride solution to the plaster model with a soft brush. In order to do rapid work the current density has to be kept as high as possible, and for this reason it was found advisable to make the etching periods between the plate cleansings and applications of solution to the model not longer than twenty seconds.

Another difficulty was caused by the breaking or wearing out of the plaster model before the etching was completed, and this was overcome in two ways, first, by making the plaster more durable, and, second, by making use of several accurately interchangeable models.

The process, as described thus far, required constant personal attention, and the next step was to devise an apparatus which would perform all the mechanical operations automatically.

It took a long time to contrive such a machine, but success was finally achieved with an apparatus which works in the following way:

The plaster models are fastened in a cast-iron frame and rest upon a table which is movable vertically by means of an eccentric. Above this table there is a support holding the metal plate to be etched. This support can also be moved up and down and can be adjusted so as to be exactly parallel to the model. Behind the table which carries the models, there is a carriage with a rotary brush. The mechanism is so arranged that the plaster model is gently brought into contact with the steel plate and allowed to remain there about fifteen seconds, when it is temporarily lowered, the brush runs over the surface of the plate and removes the insoluble powder, and at the same time a sponge moistens the surface of the model with a weak solution of hydrochloric acid, which, for various reasons, was found preferable to ammonium chloride for this particular purpose.

This method of making steel dies has now proved a complete practical success, and Herr Rieder will have one of his machines as an interesting exhibit at the Paris Exposition.

The Hennebique Iron-Concrete System of Construction.

Some years ago, M. François Hennebique, at that time living in Brussels, was called upon to build an absolutely fireproof country house. Shortly before this there had been a large fire in which a so-called fireproof warehouse, constructed of stone and iron, was completely destroyed. This convinced M. Hennebique that it was not alone sufficient to dispense with wood in constructing a building, but that the iron work would have to be protected against fire by a suitable covering. This consideration, together with the desire to build as economically as possible, led to the idea of making the floor beams of iron imbedded in concrete, with a comparatively thin concrete floor. Already recognising the fact that the metal in the beams would be subjected to a tensile stress only, he used iron rods for his longitudinal members, with some flat cross pieces.

This was the germ of the system, which has since then had a wide development, particularly in France and the neighbouring countries, and at the Paris Exposition this construction has been employed in work to the amount of three million francs.

As a good deal of attention has recently been given to this system in Austria, Herr Ed. Ast was led to read a paper on the subject before the *Oesterreichische Ingenieur- und Architekten-Verein,* which is printed in the official organ of the society, and from which these extracts are made.

If we take a concrete floor supported on four walls and reinforced by concrete ribs on its under side, we find that, when loaded by its own weight or in any other way, it will be subjected to compression, tensile, and shearing stresses. Now, it is well known that concrete can stand great pressure, but that it offers comparatively little resistance to pulls, and so it has been the object of the designers of the Hennebique system so to dispose the iron as to strengthen the concrete at the proper points and take up the tensile and shearing stresses.

Some of the details from the Grand Palais des Beaux-Arts at Paris show very clearly how this construction is carried out. We find there a floor with a span of 9.78 meters, which is extended beyond its support on one side to form a gallery floor about 3 meters wide. This floor is designed to carry a load of 550 kilogrammes per square meter, or 110 pounds per square foot, exclusive of its own weight, at a cost of 25.10 francs per square meter, 1s. 10d. or 45 cents per square foot.

In every beam of this floor are imbedded four iron rods. They lie in pairs in two vertical planes. The lower ones, which have to take up the principal part of the tensile stresses, are straight, while the upper ones are bent in such a way as to perform some special functions. Flat iron straps run from the straight to the bent rods. Near the supports these straps are closer together than in the middle of the beam. Both rods and straps are loosely laid in, the only binding material being the concrete. The ends of the rods are preferably bent into a hook shape.

If we conceive the floor to be divided by planes midway between and parallel to the ribs, it will consist of a number of T-shaped beams. Whether freely supported, or with fixed ends, each beam will be so strained at its middle point that it will be in tension at its lower and in compression at its upper surface. The neutral axis, as a rule, will lie near the surface, where the rib joins the floor proper. The T-shaped section will thus be adequate for taking up the compression, and it only remains to provide for the tensile stresses. At the point of greatest positive bending moment, the two iron rods in a vertical plane are close together at the lowest part of the rib, so that all the metal is most efficiently disposed at the greatest possible distance from the neutral axis.

If we suppose the beam to have fixed ends, there will arise negative bending moments at the supports, which will cause tension in the upper part of the beam and compression in the lower. But this is also provided for, as the bent rod runs horizontally near the upper surface of the beam in the neighbourhood of the supports, and, if necessary, can be reinforced by another rod at this point to take up any extraordinary tensile stresses. The flat straps take up the transverse tensile strains which arise in the interior of the beam, and so increase in number toward the supports.

Floors constructed on the Hennebique system are less subject to vibration than those built in other ways, and their elastic deflections are only one-third as great as with iron construction of the same capacity. These concrete floors can be covered with any kind of flooring material desired, and they offer no refuge for any vermin.

Hennebique structures are wonderfully durable and absolutely fireproof. This was shown by some experiments made at Ghent, where a small pavilion was built having two rooms, one on the ground and one in an upper story. The floor between the two, the walls, and the roof, were all constructed on the Hennebique system. The floor carried a load of 1,500 kilogrammes per square meter, or 300 pounds per square foot, the flat roof 1,000 kilogrammes per square meter, or 200 pounds per square foot. A fire was kindled in the lower room, the temperature there reaching 1,000° C. After a lapse of ten minutes the floor, under the influence of its load and the heat, showed a deflection of 0.5 millimeter, and after one hour, 13.5 millimeters. The walls then had cracks about 2 millimeters wide. The rise in temperature at the floor of the upper room was only 2° C.

After the fire had burned for one hour, it was put out; the cracks in the walls then closed up and the deflection of the floor disappeared as the structure cooled to normal temperature.

The cost of this system will depend upon the price of materials in different localities, but it can be said on the whole that where heavy loads have to be carried, it is more economical than any other, the saving in cost of construction sometimes being as great as 25 per cent.

The iron-concrete construction is used for a great variety of purposes—warehouses, private dwellings, public buildings, bridges, aqueducts and reservoirs, and even in harbour works. One of its neatest applications was at a three-story spinning-mill in Lille, where a Hennebique skeleton construction was used for the entire building, the façades of which consisted almost entirely of windows 4.28 meters wide, the intervening columns of iron-concrete being only 40 centimeters thick and the corner columns only 60 centimeters.

REVIEW OF THE AMERICAN PRESS

The Level of Lake Nicaragua.

In a recent issue of the *Scientific American*, Prof. Angelo Heilprin, F. R. G. S., F. G. S. A., presented a striking review of "An Assumed Inconstancy in the Level of Lake Nicaragua; a Question of Permanency of the Nicaragua Canal."

To this paper, which was referred to in these pages in connection with Mr. George A. Burt's article in the April issue of The Engineering Magazine, Mr. C. Willard Hayes undertakes a response in the *National Geographic Magazine*.

Prof. Heilprin's presentation of his case is briefly as follows:

Elaborate measurements by American engineers during the past fifteen years fix the present elevation of the lake surface at 105 feet (approximately) above tide. Col. Childs, in 1851, fixed ordinary high water at 111 feet 5 inches above low tide in the Pacific. Lieut. Baily's level, run in 1838 "with great care and attention by a good theodolite during a period of four months," and "particularly commended in the earlier discussions of the canal problem," placed the surface at 128 feet 3 inches above low water on the Pacific side, while the Spanish engineer, Galisteo, in 1781, made the altitude still 5 feet higher, or 133.11 feet. It is, indeed, in Prof. Heilprin's language, "difficult to understand these discrepancies in values or to assume that competent engineers should have erred over such short distances of measurement to the extent of twenty per cent. of their results; yet the concurrence of the newer results of measurement leaves no room for doubt that either Baily's and Galisteo's determinations were faulty or there has actually been an abasement of the lake level since these measurements were made."

Prof. Heilprin, finding it difficult to accept the former of these alternative explanations, adduces additional evidence suggestive of "an actual abasement of the surface, and not merely a fluctuation dependent upon the hygrometric condition of the atmosphere." Such evidence, he thinks, is afforded by the conditions noted in the northwestern extremity of the lake—the Estero Panaloya. Baily, in 1838, and Squier, in 1849, found free navigation, with 5 to 15 feet of water through the Estero and only about four miles length of channel between Lakes Nicaragua and Managua. Col. Ludlow (1895-6) states that the lakes are separated by twenty-three (?) miles, and that, in the dry season at least, the Estero is dry, any water finding its way into it from the smaller lake disappearing through fissures in the bed. Again, the discharge of Lake Nicaragua—the San Juan River—appears, from the reports of different observers, to have undergone great change. Squier, in 1850, compared it to the Hudson or Connecticut, and described it as being, for "far the greater portion of its length, capable of being navigated by our largest river steamers." Collinson, in 1867, reported to the Royal Geographical Society that it was "so low that small stern-wheelers, drawing when laden only 10 inches of water, could hardly grope their way from rapid to rapid, and were finally stalled by the swift boulder-charged current." He "gives emphatic testimony to the lowering of the level of the lake, and suggests—what is not unlikely to prove the true explanation of the phenomenon—that it may be due to increased potentiality of the outgoing or draining waters incident to a differential rise of the land surface." He says: "Every year it becomes more evident to all living on its banks or using its stream that the flow of water is becoming less in the San Juan; and even the least observant native, dwelling on the lake, will tell how its banks are rising year by year visibly before his eyes, how the River Panaloya connecting the two great lakes is becoming drier every season, so much so that at times lately no water connection has existed between them."

Prof. Heilprin calls attention to the point that: "The Baily survey was made in the interval of time between the catastrophic eruption of Coseguina (1835) on the northwest and the very violent one of Irazú (1841) on the southeast, and it was also about this period of special excitability of the crust that, as Squier reports, Nicaragua suffered most from earthquake visitations. It was in May, 1844, when the city of Nicaragua itself suffered much, that the waters of the lake 'were observed to rise and fall with the throes of the earth.' Naturally, it is to a period of this kind that one would look for most rapid or permanent terraine displacements." He calls attention to remarkable and indisputable changes in the level of Lake Ilopango, Salvador, in 1879-80, and to the point that Ilopango and Nicaragua are "hardly less than close neighbors of one another," and is disposed to believe that:

"1. The level of Lake Nicaragua is inconstant.

"2. The surface has dropped 15 to 20 feet in the period of little more than half a century."

From this conclusion Mr. Hayes dissents entirely; it is only "to one not familiar with the investigations which have been carried on in this portion of the isthmian region," he thinks, that "the conclusions reached by Professor Heilprin seem to have some foundation." His own line of argument in rebuttal is essentially an attempt to demonstrate, on purely physiographic grounds, that the assumed abasement of level could not have taken place.

Mr. Hayes says: "Three causes, singly or in combination, might bring about a change in altitude of the lake surface: (1) A depression of the whole of this portion of the isthmus without warping; (2) a depression of the lake basin by warping, the sea margins remaining constant; (3) a cutting down of the lake outlet." It will suggest itself to most minds that a fourth, and much simpler, cause might be the very obvious one of deficiency of the supplying waters.

The first is quickly disposed of by the known stability of the coast line on both Atlantic and Pacific sides. Gradually-sloping delta planes would quickly reveal any subsidence, by long invasions of the sea. A recent subsidence of a few inches near Corinto, northwest of the Nicaragua-Managua basin, was quickly recognized; "a depression of 20 feet of any occupied portion of the coast could not possibly escape notice."

The second hypothesis—local subsidence of the lake basins—Mr. Hayes considers untenable, because of the improbability that such a sinking could extend over an area 100 miles long by 45 miles broad without reaching the coast, only 12 miles away, or could proceed with such uniformity around the entire perimeter that evidences would not remain in the form of drowned shores or raised ancient beaches at divers points. Such evidences he does not find; "there is everywhere a nice adjustment of shore features to present conditions."

The third possible cause for a lowering of level—the cutting down of the outlet—Mr. Hayes thinks is removed from among the possibilities by the fact that from its point of issuance from the lake to the Toro Rapids (the sill maintaining the present level of the lake) the Rio San Juan "meanders through an alluvial plain just covered by the streams when in flood"—in other words, having "the character of a growing flood-plain"; it "represents a former extension of the lake silted up by tributary streams, but proves conclusively that the present relations have held for a considerable time." The "proof" seems decidedly imperfect. It certainly remains for Mr. Hayes to prove that this ancient lake bottom became exposed alluvial plain exclusively by silting up, and not in part by lowering of the lake. Indeed, one may well entertain the suspicion that even the Rivas "peneplain" is in part the lake bottom exposed through a shrinkage of the waters.

For the change in the Estero Panaloya Mr. Hayes finds possibly sufficient explanation in the transportation of sand by a strong littoral current, caused by the surf, and its deposit at the end of the Lake. An examination of the surveys made of this water nearly fifty years ago hardy permits of this interpretation, however. The comment of "the English engineer, Colquhoun" (Collinson ?) upon the diminishing flow of the San Juan is dismissed as coming from "a superficial observer whose conclusions were drawn from a relatively short period of observation." One would think that the shorter the period within which so very definite observation could be made of the falling of the San Juan River and visible rising of the banks of Lake Nicaragua, the more pronounced and unmistakable the phenomenon must be.

On the whole, Mr. Hayes' paper leaves the impression that something more is needed to disestablish Professor Heilprin's conclusions. The known range of the lake levels within a few years has been 14 feet—though, by the way, Mr. Hayes' arguments run almost as strongly counter to these established facts as to the assumed further range of 20 feet—and it seems to demand more than an allegation of improbabilities or the marshalling of negative evidence to impugn finally the accuracy of the earlier surveys. Kingsley once said no one could deny the existence of water-babies till he had seen them *not-existing*, which was a very different thing from not seeing them exist. Perhaps it is true of "raised beaches" also.

The Steam Turbine.

THERE are probably few subjects in mechanical engineering upon which there is so little literature in proportion to the demand as in the case of the steam turbine. Possibly it is because the development has been, almost from the start, a commercial one. The experimenters have been naturally unwilling to give out imperfect results—still more naturally convinced of the inexpediency of making public property of conclusions which have cost them heavy expenditure of money, and many months of study and labor.

It has come to pass, therefore, that the Viper has made her surprising trial runs in England, and the stationary power-plant of turbines has been installed at the Westinghouse Air-Brake Company's works at Wilmerding, Pa., while the engineering world is still guessing at the exact construction of the interior of the Westinghouse-Parsons turbine.

An interesting general account of the latter installation is given in *The Iron Age*, with plans and elevations of the exterior of a 500-horse power and a 2,500-horse power turbine. Three units of the smaller size now furnish the entire motive power for the air-brake plant, the old engines having been completely removed. Each unit is direct-coupled to a 300-kilowatt two-phase alternating-current machine, the three being run in parallel.

A striking feature of the installation is said to be its compactness; although the machines "aggregate 1,500 horse power, yet, standing side by side, the space occupied is only 25 by 20 feet, although there is ample space for all purposes. The bed plate of each machine measures 16 feet 7 inches by 4 feet 3 inches. The whole plant, including two 10-horse power steam engines operating generators for exciter purposes, two pairs of condensers and air pumps, and the switchboard, occupies a space of only 29 by 30 feet. The foundations consist of ordinary brick piers, without any holding-down bolts, which are unnecessary on account of the absence of reciprocating parts.

"The speed of the turbines and generators is 3,600 revolutions per minute. The weight of each complete turbine and generator is 25,000 pounds. The turbines are designed for condensing the exhaust, which is accomplished by means of a combination of a pair of jet condensers and compound air pumps, in which the air and water are handled in separate cylinders. The vacuum is often as high as 28 inches, while the average barometer is 29.25 in Pittsburg. The delivery water is only a fraction of a degree different in temperature from that of the steam in the condenser. The thermal operation of these turbines is very striking, for although the live steam entering the turbines at 125 pounds' pressure has a temperature of about 350 degrees, yet the exhaust temperature at a point about four feet distant is only a trifle over 100 degrees, the exhaust pipe being cool enough to be handled comfortably. This is a remarkable exhibition of the transformation of heat into work, and the condensation must be slight, if any, or the closely fitting parts would not operate so smoothly at this high speed."

The moving parts of the turbine consist of a shaft carrying three drums of different diameters, increasing in steps like a cone-pulley. This revolves within a cylinder correspondingly enlarged in steps from inlet to exhaust end. On the interior of the cylinder and on the exterior of the shaft drums are fixed numerous rows of "guide blades or curved vanes about three inches in height," disposed radially and so arranged that the rows on the drums fit between those on the cylinder walls. Through the annular space into which these vanes project the steam flows, being directed by the fixed blades so as to exert its maximum effect on the revolving vanes, and attaining increased degrees of expansion by passing into constantly enlarging spaces between the rows of vanes and between the individual vanes making up each row. "The turbine is thus a multi-expansion engine with as many expansions as there are rows of blades. The total expansion ratio between inlet and exhaust is 96 to 1."

The turbine is governed by intermittently cutting off the steam supply entirely for a longer or shorter period, according to the load. The governing is said to be extremely sensitive, and capable of adjustment within a fraction of 1 per cent. between full load and no load.

The 2,500-horse power turbine approaching completion at the Westinghouse Machine Company's works is said to be the largest unit yet attempted, two of 1,400-horse power being under construction in England for a German electrical plant. The shaft of the 2,500-horse power turbine, complete, will weigh 28,000 pounds. The diameter of its largest moving part will be 6 feet. It is to make 1,200 revolutions per minute with steam at 150 pounds.

Some interesting details of the shop methods employed in making these huge shafts and casings were given in Mr. Roland's illustrated article in the February issue of THE ENGINEERING MAGAZINE.

The Langen Monorail.

REVIEWING the Caillet monorail in these columns (January, 1898), the opinion was expressed that the Caillet system might find application on account of the modesty of its pretensions—it attempted nothing further than the establishment of a simple portable form of suspended industrial railway for goods carriage—but that the single-rail tramway, in competition with the ordinary system, had no *raison d'être*. The same view is repeated and emphasized in some of the journals which have recently published illustrated descriptions of the Langen suspended railway, now under construction and reported by the *Street Railway Review* to be half completed between Barmen and Vohwinkel, a distance of about 8 1-3 miles. The *Review's* account is based upon a consular report, while *Engineering News* has a translation, with commentary, from the *Zeitschrift des Vereines deutscher Ingenieure*. Rather important differences in the matter of figures of weights, measurements, and cost are apparent in the two accounts.

In Herr Langen's original experiments with a suspended-carriage railway he used a two-rail system and secured a speed of only 7½ miles an hour. A second attempt, with a single rail, was attended with better success and 15½ miles an hour were made. Thus encouraged, the owners of the patents proposed and secured permission to erect the pioneer service line under the system, in place of an elevated road for which the municipalities of Barmen, Elberfeld, and Vohwinkel were planning.

The road runs in part over the small river Wupper and in part over the highway. The supporting structure consists essentially of a series of light trusses, of varying span with an apparent maximum of 98 feet, carried on inclined posts over the river and on curved posts over the street. The rails (it is a two-track road) are of T section, laid on iron plates bolted to the supported spans, with a layer of felt interposed to reduce vibration and noise. One rail is carried on each side of the span, at the bottom, the width of the truss being sufficient to allow the cars to pass.

The cars, each of which is to carry 50 passengers, are suspended from two-wheel trucks, two trucks to each car, running on the T rails, and the form of suspending arm is said to be such as to prevent derailment. Between the two axles on each truck is a 36-horse power 500-volt electric motor, current being taken from a contact rail by a slip shoe. The braking system seems ample. A speed of 18 miles an hour, including stops, or 25 miles an hour maximum, is expected. The road is to be in operation early in 1901.

The *Review* and *News* agree substantially that the maximum grade is 4.5 per cent. and that main-line curves wherever possible are made with minimum radius of 300 feet; but the *Review* gives the minimum radius on sidings as 27 feet, the weight of supporting structure as 838 pounds per lineal foot over the river and 783 pounds over the highway, and the cost as $200,000 to $225,000 per mile, including foundations and stations—while the *News* gives the minimum radius on sidings as 19 feet, the weight as 766 pounds per foot over the river and 715 pounds over the highway, and the inclusive cost as $172,000 to $192,000 per mile, these figures agreeing with those given in the German papers.

The *News* considers "that the swinging of the car in pendulum fashion, as it rolls along, might be so considerable as to make riding very uncomfortable for persons with a tendency to sea-sickness." As the experimental cars swung outwards on the curves, at an angle of 25 degree from the vertical, this supposition seems well founded. Altogether it is a curiosity of engineering, if not a "monstrosity not likely to be anywhere repeated."

Failure of the Austin Dam.

THE failure of the Austin (Tex.) dam, with attendant destruction of the power house and the loss of eight lives, has been treated at considerable length, especially by *Engineering News,* which had an excellent early telegraphic report and a later illustrated account, or rather series of accounts, by several eyewitnesses. These latter are of particular interest because they are by engineers—Dr. H. W. Chance and Prof. T. U. Taylor—who were on the spot immediately after the break, and the accompanying photographs furnish an almost continuous record of the accident up to the time when the flood had subsided. *The Engineering Record* gives a succinct history of the construction of the dam. It is noteworthy, however, that all the accounts are confined very closely to the records, and comment, deduction, or editorial opinion is almost entirely lacking.

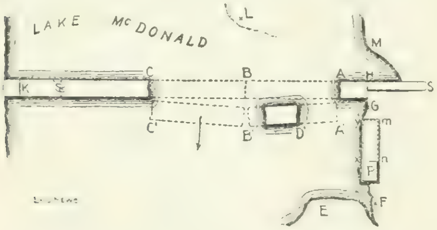
The dam was 1,125 feet long on the overflow line, 1,275 feet on the crest, 66 feet through at the base, and 68 feet high above bed rock. It was of masonry throughout, with cut-stone faces and heart of heavy rubble masonry laid in cement mortar, the interstices being filled with concrete. It rested on limestone, which seems to have been rather unsatisfactory. A good deal of trouble was met with during construction from strong springs in the bed and the adjoining bluffs.

Mr. John P. Frizell made the original report and began the work as chief engineer in 1890; in 1892 the Austin Board of Public Works called in Mr. E. Geyelin and Col. J. T. Fanning, and shortly after Mr. Frizell withdrew and the work was contined under Mr. E. W. Groves, with Col. Fanning as consulting engineer. Important changes from Mr. Frizell's plans were made, particularly in the form of the crest and in the location of the power house, which was moved close to the dam instead of about 600 feet below, as proposed by Mr. Frizell. It is noteworthy, too, that while Mr. Frizell's drawings show four cut-off trenches in the bed rock, later sketches show but two; when the change was made is not apparent, but as the dam was about two-thirds completed when he withdrew, it would seem that it must have been under his regimé.

The following account of the failure is given to *Engineering News* by Prof. T. U. Taylor, Assoc. M. Am. Soc. C. E.; the accompanying sketch is reproduced.

"From 1 P. M., April 6, to 4 A. M., April 7, there was a rainfall of 5 inches at and in the vicinity of Austin, in a mountainous country, on ground already wet. In addition to this tremendous rains fell all along the Colorado and its tributaries from Austin as far up as Llano, a distance of over 100 miles. The Colorado rose rapidly, and by 10 A. M. Saturday (April 7) it was apparent that the dam was to withstand the biggest flood since water first wetted its crest on May 16, 1893. At this hour the water level of the lake was over 10 feet above the crest of the dam and was rising rapidly. The greatest previous flood height occurred at 9 P. M., June 7, 1899, when the lake level was 9.8 feet above the dam crest.

"At 11:20 A. M., April 7, when the lake level had reached a height above the dam crest of 11.07 feet, the dam gave way at B, about 300 feet from east end of dam. Observers at E, F and H all unite in their testimony that it first opened at B, as if the mad current had simply pushed its way through the structure. Sooner than it takes to write these words, the two sections A B and B C, each about 250 feet long, were shoved or pushed into the positions A′B′ and B′C′, about 60 feet from their former position in the dam. There was not the slightest overturning. After the warning break at B, the water over the part A B C was seen to rise several feet, and the next instant the pent-up water was pouring over the sections A′B′ and B′C′. At 11:30 the lake level fell to the crest of the dam, and the two sections A′B′ and B′C′ were seen to be upright, each still a solid mass, complete, unbroken, and intact (except for the scaling off of the granite facing from the down-stream face), occupying a position practically parallel to the dam. To the casual observer, the detached portions at this time had the appearance of having been erected in their new positions by the original contractor. The crests of A′B′ and B′C′ were about on the same level with their original position except at C′, which was slightly higher, giving B′C′ a slight longitudinal dip towards the power house. Measuring along the crest, the break left about 500 feet of the dam, K C, at the west end, and 83 feet, A H, at the east end, still standing unaffected.



"As soon as the sections were broken out and moved to the positions A′B′ and B′C′, the partially pent-up waters rushed through the gap, and that part held back by C K produced a strong current in the direction of the power house. The current struck the power house wall almost on a level with the pump-room floor (about 12 feet below the crest of the dam), crushed in all the windows on the west side, flooded all the lower stories, and caught and drowned five employees and three small boys. Two of the employees miraculously escaped by climbing through a belt hole in the dynamo room, *x y m n*. These workmen were pumping water from the lower portions of the power house.

"At 12 o'clock, 40 minutes after the break, the broken section B′C′ turned over towards the dam and disappeared beneath the torrent, and the eastern end of the section A′B′ was broken up and engulfed. This left about 100 feet, B′D′, which was shifted slightly out of its parallel position. This section, B′D′, was cracked from the crest as far down as could be seen. Sometime during Saturday night the smallest portion of this 100-foot section was swept away.

"At 12:05 A. M. Sunday, April 8, the northern two-thirds, *x y m n*, of the west wall of the power house gave way and fell, taking with it that part of the roof over the dynamo floor, and badly wrecking the corresponding part of the east wall."

We are informed that Mr. Frizell had contemplated the possibility of a flood of sixteen feet above the crest, whereas the break occurred with but eleven feet passing over. The curious feature is that there was no overturning—the dam as a whole seems to have slipped. We believe it has been generally considered that the frictional resistance secured by the weight on the foundation was enormously greater than any pressure which could be brought to bear.

Professor G. S. Williams has suggested a highly interesting explanation, which is, in brief, that the vacuum back of the fall, created by the falling water, became unusually high under the increased flow, and unbalanced atmospheric pressure was thus added to the weight and force of the stream itself. There was, we are informed, no provision for ventilating the space between the falling sheet and the lower face of the dam.

Fuller explanation of the contributing causes and exact accounting for responsibility are yet to be made. We may quote once more from *Engineering News:*

"In July, 1893, Mr. E. W. Groves, the engineer in charge of the dam after Mr. Frizell's resignation, also resigned. He gave as one of his reasons for this action constant interference in the engineering work by Mr. John McDonald, Mayor of Austin, and President of the Board of Public Works. Mr. Groves' resignation has been mentioned because it served to bring out some very decided statements regarding the interference of Mr. McDonald with the prosecution of the work, and because it seems to substantiate claims to the effect that he and other members of the Board of Public Works really initiated controversies which afterwards caused so much trouble among various engineers. In our issue of June 29, 1893, in an account of the failure of the dam published in one of the Austin papers, there appeared what purported to be official communications from the secretary of the Board of Public Works to Mr. Jas. Waterson, the contractor for the power house, and to Mr. N. Werenskold, engineer, instructing both 'to follow instructions of the Mayor with reference to excavation and the building of the power house, foundation, abutment wall, and other work.' "

Sewage Disposal Legislation.

WITH increase of density of population, the need for sound and effective action in the matter of water supply and sewage disposal forces itself upon the community with so rapid a rise of pressure that it is surprising only that the pressure was so long in being converted into motion. Most European countries long since reached the point where it became necessary in the public interest to put these matters under definite and consistent regulation. The United States are apparently beginning to see the same conditions, but as yet matters are in a most unsatisfactory condition, and it would appear, from the paper lately read by Mr. George Janin before the Canadian Society of Civil Engineers, that affairs in the Dominion are also much in need of improvements.

The rapidly growing population over almost all collecting areas, the upspringing of manufacturing towns in series along formerly unpolluted rivers, and, perhaps more than all, the advance of bacteriological and sanitary science, dispelling many illusions as to self-purification of streams—all these have joined to fasten attention upon two prime necessities: the purification of sewage and manufacturing wastes, or their direction elsewhere than into rivers or other fresh waters; and the purification of public water supplies by some means efficient in reaching not only suspended or dissolved impurities, but bacterial forms. And in this, by the way, slow sand filtration has proved most efficient, as witnessed by results at many plants—notably the large one at Albany lately reviewed in these pages (January and May, 1900).

The two processes obviously bear totally different relations to the interests of the public—the latter affecting only the community directly concerned, while the former (or, rather, the neglect of the former) involves the rights of every riparian owner, individual or corporate, below the point of possible pollution. Yet it seems, unfortunately, as if in most of the States of the Union the use of a stream as a sewer had been almost as free as its utilization for water supply. Courts, in more than one instance, have taken the position to which *The Engineering Record* refers in discussing a recent leading case in New Jersey—they will not "grant an injunction preventing the discharge of sewage into the river to the injury of the owners, but will merely allow them damages for the effects of the pollution. In the words of the court: 'They may obtain redress by amending their bill, or by filing a new bill praying for an injunction unless the city of Paterson' (the defendant corporation in this case) 'will consent to make such compensation to them as shall be ascertained to be just; or they may, if they elect, sue at law for their damages.' " A similar ruling, we believe, was made in Ohio some years ago, though, as the *Record* points out, a Connecticut court in a recent case enjoined the polluters, and Massachusetts has for some time occupied an enlightened position with regard to prevention of river pollution.

The folly and injurious inconsistency of legislative action in connection with these two vitally related matters is strikingly shown in the New Jersey case just referred to. The State legislature, as the *Record* shows, nearly fifty years ago gave to Jersey City (a party to the complaint in the action cited) permission "to draw from the Passaic River a supply of pure and wholesome water." But at subsequent dates the same body gave to Paterson and Newark permission to build sewage systems discharging into the same river above Jersey City. "The permission to obtain a supply of 'pure and wholesome water' from the river merely gave the city the right to get it if it was there; it did not guarantee that the State would use its authority to keep the river free from pollution."

It is highly interesting, therefore, to note that an apparently direct outcome of this case has been the immediate passage by the New Jersey legislature "of an act increasing very largely the field of the State Sewerage Commission, which is now, in some respects, clothed with powers probably approaching more nearly those of foreign river-pollution commissions than any other body in the United States.

"The Commission has five members appointed by the governor and serving three years. They are paid a salary of $1,500 each, and are allowed to have a secretary, employ assistants and retain experts as occasion warrants. The Legislature keeps a tight rein on the Commission by means of its power to withhold appropriations, for the new act states that the Commission 'may expend such sums of money as shall be duly appropriated.' Those who are familiar with State legislation do not need to be told that such a clause is heavily laden with meaning. A previous organization in the same State for the same purpose was wrecked by a somewhat similar provision for meeting its expenses.

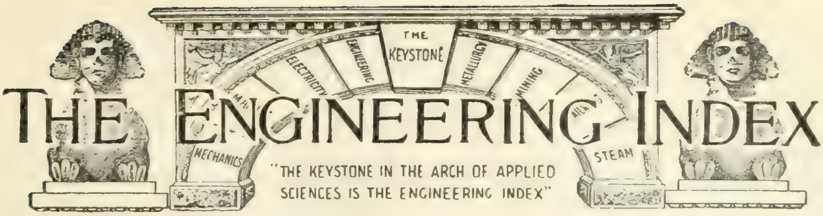
"Fortunately for the welfare of the people, the Commission will be little hampered by the financial obligations it must meet, for the expense attendant on the work must be almost wholly met by the local authorities. The Commission's duties are to study the various methods of sewage disposal and investigate all complaints of the pollution of the waters of the State which may be brought to its notice; if pollution injurious to the health, comfort or property of any inhabitants of the State is found, the Commission must notify the person or corporation causing it, to cease the nuisance and dispose of the sewage in some manner approved by the Commission. The pollution must cease at a time fixed by the Commission, not later than five years from the date of the notice.

"No sewerage system and no sewage treatment works discharging into the waters of the State may be built hereafter until the plans have been approved by the Commission, although existing works are to be allowed to remain in service until the Commission has notified the authorities that changes must be made, as described in the last paragraph. Violations of the provisions of the act may be stopped by writs of injunction issued by the court of chancery on the application of the Commission, after a summary hearing.

"To place the design and construction of sewerage systems and sewage disposal works on the shoulders of any State commission would be foolish, so a provision for the formation of sewerage districts has been made. These are quasi-municipalities, much like the Sanitary Drainage District of Illinois. Their purpose is to organize all the localities which should have a single system of sewerage or sewage disposal works into a political body entirely distinct from the present municipal and township corporations. * * * The interesting feature of their work is the fact that it must all be done subject to the approval of the State Commission. Construction, maintenance and operation are all under the control of the latter body."

Of course, legislation in the United States must be considered tenative until it has been tested in the courts. The *Record* concludes: "If the Legislature chooses to delegate its rights to permit and check the pollution of streams to a Commission reporting annually to itself, it apparently has the power. The trouble will arise, if it does occur, when the Commission attempts to compel some municipality to change its present system of disposal. The courts must then decide whether there is any law and equity by which to force a municipality to reconstruct its sewerage system so as to discharge into some other place than the existing outlet, when the latter has been used heretofore with the consent of the Legislature."

The outcome will be watched with the greatest interest. It is hardly credible that the courts will finally decide otherwise than in a spirit of reason, guided by engineering and sanitary science, and in recognition that liberty to the individual is the measure of freedom remaining when the rights of the remainder of the community have been protected from invasion. And that the discharge of untreated sewage or similar pollution into a stream is, in general, an invasion of public rights can no longer be for a moment disputed.



THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.

Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Apartment Houses.

The New Houses of J. Kalb, on Friedrichstrasse, Munich (Die Neubauten J. Kalb, Friedrichstrasse 9 u. 11 in München). Illustrated description of a fine block of buildings in harmony with its surroundings. 400 w. Deutsche Bauzeitung—March 17, 1900. No. 33500 B.

Arch.

A Great Arch, Cathedral of St. John the Divine. Illustrated description of the design and execution of a great masonry arch on the top of piers 86 ft. high. The span is 114 ft. out to out of vousoirs. 1800 w. Eng Rec—March 31, 1900. No. 33321.

Chimneys.

Chimney Height and Area. Review of a paper by H. C. Brinckerhoff before the N. E. Cotton Mfrs. Assn., describing the procedure for designing a chimney for a given purpose. 1000 w. Eng Rec—April 28, 1900. No. 33881.

Collapse of a 200-Ft. Brick Chimney. Illustrated description of a stack which failed before it was put in use. 600 w. Eng Rec—April 28, 1900. No. 33882.

The Ornamental Chimneys at the Paris Exposition (Die Zierschornsteine der Weltausstellung in Paris 1900). G. Lang. An illustrated account of the two tall ornamental chimneys for the power plant. 2000 w. Zeitschr d Ver Deutscher Ing—April 7, 1900. No. 33563 D.

Depot Shelter.

The Lyons Depot Shelter, Paris. Illustrated description of a very large shed built over the site of a railway station head-house which was constructed within its shelter. 500 w. Eng Rec—April 21, 1900. No. 33740.

Dome.

Dome Framing, Appellate Court House, New York. Illustrated description of a cylinder framework carrying an upper and a lower dome, supported by brackets from girders of two stories. 500 w. Eng Rec—April 14, 1900. No. 33660.

Fireproofing.

The Horne Fire, Pittsburg. Illustrated description of the results of a fire in a six-story department store, where the contents were almost wholly destroyed without material injury to the steelwork, owing to the protection afforded by fireproofing. 2500 w. Eng Rec—April 14, 1900. No. 33656.

The Second Fire in the Fireproof Horne Store Building, Pittsburg, Pa. Information concerning this fire, with illustrated description of the damage. 1000 w. Eng News—April 26, 1900. No. 33820.

Floors.

Concrete Floors. Frank Caws. Read before the Northern Archt. Assn., at Newcastle. Describes work from the writers' experience, and urging the fireproof construction for all buildings. Ill. 8200 w. Jour Roy Inst of Brit Archts—March 10, 1900. No. 33499 A.

Foundations.

Floating Foundations for Mexico City. J. A. Waddle. Describes a plan to make a solid framework by metal and concrete which shall resist injury from unequal settlement and damage by earthquakes. 900 w. Am Mfr & Ir Wld—April 19, 1900. No. 33763.

Hotel.

Plans for Altering the Inn "zum Weissen Hirschen" in Rothenburg, Bavaria (Entwürfe zur Umgestaltung des Gasthofes zum Weissen Hirschen in Rothenburg O. T.). Illustrated description of plans for bringing this inn into harmony with its mediæval surroundings. 400 w. Deutsche Bauzeitung—March 28, 1900. No. 33501 B.

Japanese Building.

A Japanese Imperial Palace. Illustrated description of the details of the palace of the Crown Prince, the highest building in the country, noteworthy for the elaborate details of the steel-work to prevent distortion by earthquakes. 2000 w. Eng Rec—April 7, 1900. No. 33423.

Materials.

Materials of Construction for Farm and County Buildings (Bedeutung und Enewickelung des Landwirthschaftlichen Bauwesens). Prof. August Prokop. Various tables containing a large number of data concerning materials ordinarily met with in country districts in Austria. Serial. Part 1. 600 w. Weiner Bauind Zeit—April 5, 1900. No. 33547 D.

Paris Exposition.

The Monumental Entrance at the Place de la Concorde (L'Entrée Monumentale de la Place de la Concorde). G. Leugny. An illustrated account, with details of construction, of the main entrance to the Exposition. 2400 w. Revue Technique—March 25, 1900. No. 33599 D.

Prison.

The New Prison Buildings of the Department of the Seine (Les Nouvelles Prisons du Département de la Seine). P. Basquin. A well illustrated description of new penal buildings constructed on modern principles. Serial. Part 1. 7000 w. 1 plate. Génie Civil—March 17, 1900. No. 33589 D.

Reconstruction.

The Reconstruction of the Grand Central Station, New York. Illustrated description of the methods adopted to put in the foundations of heavy walls across tracks in almost constant use. 1400 w. Eng Rec—April 28, 1900. No. 33880.

Roof Trusses.

How to Determine the Stresses in Unsymmetrical Roof Trusses, or in Trusses Unsymmetrically Loaded. F. E. Kidder. An illustrated article showing how to draw the stress diagram. 2000 w. Arch & Build's Mag—April, 1900. Serial. 1st part. No. 33401.

HEATING AND VENTILATION.

Forced Circulation.

Mechanical Ventilation and Heating. Illustrated abstract of lecture by Walter B. Snow on the financial advantages of mechanical draft and ventilation. 2200 w. Eng Rec—April 21, 1900. No. 33739.

House Heating.

Fuel Necessary to Heat Small Buildings (Combustile Nécessaire pour le Chauffage d'un Local). Short article by J. Orpiszewski in the *Revue technique de Varsovie,* abstracted in the *Bulletin de la Société Vaudoise des Ingenieurs et des Architects,* showing how to determine the amount of fuel necessary to keep a room at a given temperature. 400 w. Moniteur Industriel—March 31, 1900. No. 33-596 E.

Large Buildings.

Ventilation of Large Buildings. Merwyn O'Gorman. Read before the Civ. and Mech. Engs.' Soc. of London. Discusses methods used and the importance of furnishing 1000 cubic feet of air per hour for each person. 4400 w. Arch't, Lond—March 23, 1900. No. 33377 A.

Ventilation and Heating of the Methodist Episcopal Home for the Aged, Philadelphia. Illustrated description of a plenum system in a building having an unusual amount of exterior wall surface in proportion to its floor area, and a more exposed location than structures usually heated in this way. 2500 w. Eng Rec—April 28, 1900. No. 33884.

Steam Heating.

The Distribution of Steam at Dartmouth College. Illustrated description of the system employed in heating 16 detached buildings from a central station, with details of the special features of the expansion joints and devices. Also gives results of a boiler test. 2500 w. Eng Rec—March 31, 1900. No. 33327.

PLUMBING AND GAS FITTING.

Hot Water.

The Heating of Water (Warmwasserbereitung). M. Grellert. An illustrated account of a system of heating water for various purposes in a house by means of the kitchen fire, with calculations of the efficiency of the system. Two articles, 3600 w. Gesundheits Ing—March 15, 31, 1900. No. 33519 each B.

Office Building.

Plumbing in the Broadway Chambers Building, New York. Illustrated description of work which has no pressure tanks on the roof for the water system, using compressed air receivers instead, and employing closet-flushing apparatus without flush tanks. 1000 w. Eng Rec—April 7, 1900. No. 33424.

MISCELLANY.

Acoustics.

Architectural Acoustics. Wallace C. Sabine. A description of the various causes of defective sound distribution in rooms, and of methods of investigating them, both quantitatively and qualitatively. 3900 w. Eng Rec—April 14, 1900. No. 33659.

Architectural Acoustics — Reverberation, Absorbing Power of Wall Surface. Wallace C. Sabine. Illustrated description of the methods of determining the reverberation and absorbing power of rooms in terms of open windows as units of measurement. 3500 w. Eng Rec—April 21, 1900. No. 33738.

Architectural Acoustics—Reverberation, Approximate Solution. Wallace C. Sabine. Explanation of a method of providing for the absorption of reverberation in halls as soon as their shape has been learned. Ill. 1800 w. Eng Rec—April 28. 1900. No. 33883.

Laboratory.

The Carnegie Laboratory of Engineering. Illustrated description. 1500 w. Stevens Ind—April, 1900. No. 33837 D.

New Patent Office.

The Need of a New Building for the United States Patent Office. George L. Morton. Reviews the history of this department, and shows the urgent need of a new fire-proof building. 3500 w. R R Gaz—April 13, 1900. No. 33648.

Paris Exposition.

The Paris International Exhibition. A critical review of the exhibition at the opening, with plans. 6500 w. Engng—April 20, 1900. No. 33942 A.

CIVIL ENGINEERING

BRIDGES.

Arcade Girder.

The Vierendeel Arcade Girder (Pont à Arcades, Système Vierendeel). A. Morizot. A long illustrated description, with the theory of the truss. Serial. Part I. 2000 w. Revue Technique—March 10, 1900. No. 33597 D.

Construction.

Special Bridge and Viaduct Construction in Western Pennsylvania. Illustrated description of the details and construction of 22,000 tons of viaducts and bridges on the Carnegie railways. Part first describes mainly the viaducts, including one which carries two tracks at different elevations. 1500 w. Eng Rec—April 28, 1900. Serial. 1st part. No. 33878.

East River Bridge.

Mason Work on the New East River Bridge Anchorages. Illustrated description of the design, and contractors' methods. 1900 w. Eng Rec—April 7, 1900. No. 33418.

Lift Bridge.

An Electrically-Operated Bridge. Describes the method of operating a lift bridge of 34 ft. span and 66 ft. width. 500 w. Eng Rec—April 7, 1900. No. 33422.

Memorial Bridge.

The Memorial Bridge Across the Potomac. Illustrated description of the design submitted in the limited competition for a bridge of about 3,500 ft. length, between Washington and Arlington, as a monument to American patriotism. The prize design employs concrete steel construction very largely. All designs were prepared by engineers and architects working together. Also an editorial on the importance of the competition. 11200 w. Eng Rec—April 21, 1900. No. 33733.

Rapid Construction.

Hopetown Bridge. Brief account, with illustrations, of the rebuilding of the channel span of the road bridge over the Orange River, in Cape Colony, in 18 days after the receipt of the order. 500 w. Engng—March 23, 1900. No. 33-390 A.

Repairing.

Repairing a Fractured Stone-Arch Bridge, P. and R. Ry. Illustrates and describes an interesting and somewhat unusual piece of masonry work. 1300 w. Ry & Engng Rev—March 31, 1900. No. 33360.

Stresses.

The Position of Wheel Loads Causing Maximum Stresses in Web Members. M. A. Howe. Considers only simple trusses which have one set of web members vertical. Ill. 1200 w. R R Gaz—April 20, 1900. No. 33758.

Train Loads.

American Train Loads in the Calculation of Bridges (Ueber Amerikanische Belastungszüge für die Berechnung von Brücken). F. C. Kunz. An article with a table and diagrams comparing the bridge loads on various American and foreign railways. 1000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst —April, 1900. No. 33530 G.

CONSTRUCTION.

Columns.

The Practical Column Under Central or Eccentric Loads. J. M. Moncrieff. Deduction of new formulæ and development of a theory of column resistance. Diagrams. 25000 w. Pro Am Soc of Civ Engs—March, 1900. No. 33307 E.

Foundations.

Notes on Foundations (Einiges über Fundamente). Adolf Francke. Particularly on the proper distribution of pressure. Formulæ, with diagrams and examples. 600 w. Schweiz Bauzeitung—April 7, 1900. No. 33540 B.

Frameworks.

The Exact Design of Statically Indeterminate Frameworks. An Exposition of Its Possibility, but Futility. Discussion of paper by Frank H. Cilley. 16300 w. Pro Am Soc of Civ Engs—April, 1900. No. 33806 E.

Hennebique System.

The Hennebique System (Das System Hennebique). Ed. Ast. An illustrated description of Francois Hennebique's system of construction with structural steel and iron imbedded in concrete, with its application in a variety of cases. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—March 30, 1900. No. 33550 B.

Metal Protection.

Experiments on the Protection of Steel and Aluminum Exposed to Water. Continued discussion of paper by A. H. Sabin on this subject. 1300 w. Pro Am Soc of Civ Engs—April, 1900. No. 33-803 E.

Roads.

Notes on Road Construction and Maintenance. A statement of experience gained during 1899 on the Massachusetts

State roads, together with a brief description of the methods of constructing roads for traffic of different sorts in Great Britain. 1500 w. Eng Rec—April 21, 1900. No. 33734.

Sewers.

Formulas for Computing Quantities of Brickwork in Egg-Shaped Sewers. Philip P. Farley. Formulas given were developed for the writer's own use. 400 w. Eng News—April 19, 1900. No. 33-727.

Tunnel.

Building the Ronco Tunnel, Near Genoa, Italy. From *Le Génie Civil*. Briefly describes the method of reconstruction, giving illustrations. 800 w. Eng News—April 19, 1900. No. 33725.

New York and the Rapid-Transit Tunnel—What Streams and Creeks It Cuts Through. A short description of the creeks underlying Manhattan island which must be diverted or arched over. 1400 w. Fire & Water—April 7, 1900. No. 33443.

The Blackwall Tunnel, London. Illustrations and brief description of the construction, of interest in connection with the project for connecting Brooklyn and Manhattan by tunnel. 1800 w. Sci Am—April 7, 1900. No. 33410.

HYDRAULIC AND WATER SUPPLY.

Canals.

See also "Panama" and "Nicaragua."

The Trans-Isthmian Canal. Henderson Gilbert. A review of the various projects for the construction of such a canal, and the present outlook. 1800 w. Yale Sci M—April, 1900. No. 33606 C.

The Ship Canal Across the American Isthmus. A review of the engineering difficulties not considered in the report of the Walker commission which investigated the Nicaragua route. 1300 w. Eng Rec—April 28, 1900. Serial. 1st part. No. 33876.

The Rhine-Elbe Canal—A Feature in German Politics. James Howard Gore. An explanation of the importance of this project. 1800 w. Rev of Revs—April, 1900. No. 33351 C.

Conduits.

New Gaugings of the Rochester Conduits. Describes the results of measurements on the old and new Hemlock conduits in 1898, indicating a slight reduction in their carrying capacity. 1500 w. Eng Rec—April 7, 1900. No. 33419.

Dam.

The Foundations of the New Croton Dam. Discussion of paper by Charles S. Gowen. 7500 w. Pro Am Soc of Civ Engs—April, 1900. No. 33804 E.

The Reconstructed Canyon Ferry Dam, Near Helena, Mont. Illustrated description of the original dam and its reconstruction, with comments. 1000 w. Eng News—April 26, 1900. No. 33819.

Dam Failure.

Failure of the Great Masonry Dam Across the Colorado River at Austin, Tex. Illustrated description of the break which occurred on April 7, with an outline of preceding troubles, and review of the work. 2000 w. Eng News—April 12, 1900. No. 33644.

The Failure of the Austin Dam. Illustrated description of the construction of this masonry dam, 1,275 feet long and 68 feet high, of the overflow type, which was wrecked by a flood. 2200 w. Eng Rec—April 14, 1900. No. 33655.

The Failure of the Austin Dam. Reports of the failure from T. U. Taylor, H. M. Chance, and A. B. Roome, with illustrations. 6000 w. Eng News—April 19, 1900. No. 33724.

Failure of the Austin Dam. R. D. Parker. Illustrated description of the failure of a 68-foot masonry dam, written by an engineer who was at the scene soon after the accident, and personally interviewed reliable witnesses of the break. 1000 w. Eng Rec—April 21, 1900. No. 33737.

The Failure of the Masonry Dam at Austin, Tex. Brief illustrated description, with remarks on the probable cause of the disaster. 1000 w. Sci Am—April 28, 1900. No. 33829.

Erie Canal.

The Improvement of a Portion of the Jordan Level of the Erie Canal. Continued discussion of paper by William B. Landreth on this subject. 4500 w. Pro Am Soc of Civ Engs—April, 1900. No. 33805 E.

Filtration.

The Albany Water Filtration Plant. Continued discussion of paper by Allen Hazen. 8000 w. Pro Am Soc of Civ Engs—April, 1900. No. 33808 E.

Iron Removal from Ground Water at Far Rockaway by Slow Sand Filtration. Illustrates and describes the apparently efficient plant of the Queens County Water Company. 1200 w. Eng News—April 12, 1900. No. 33643.

Slow Filtration at Albany. A discussion of the results of the operation of the covered sand filters, by G. I. Bailey, G. C. Whipple, and G. W. Fuller. 3900 w. Eng Rec—April 7, 1900. No. 33420.

Slow Sand Filtration, Nyack, N. Y. Illustrated description of the details of a pair of open filter beds, with a combined area of 1-3 acre. 800 w. Eng Rec—April 28, 1900. No. 33879.

Floating Dock.

700-Foot Floating Dock at South Brooklyn. Illustrated description of this large pontoon dry-dock which is under construction, and of the method of docking a ship. 1400 w. Sci Am—April 21, 1900. No. 33716.

Floods.

Work Done for the Controlling of Irregular Streams in Austria (Die Bisherige Thätigkeit auf dem Gebiete der Wildbachverbauung in Niederösterreich). An account of the work already done to prevent disastrous overflows from brooks and small streams in Lower and Upper Austria, with tables. 3300 w. Oesterr Monatschr f d Oeffent Baudienst—April, 1900. No. 33532 G.

The Prevention of the Flooding of the Embankment of the Austrian North-Western Railroad (Uber die im Vorjahre von der Oesterr. Nordwestbahn getroffenen Massnahmen gegen eine Ueberflutheung des Bahndammes zwischen Bisamberg und Stockerau). A. Walzel. An illustrated account of the precautions taken and the effective work done at the time of the floods in the fall of 1899. 4500 w. Zeitschr d Oest Ing u Arch Ver—March 16, 1900. No. 33548 B.

Flow.

Experiments in the Flow of Water in the Six-Foot Steel and Wood Pipe Line of the Pioneer Electric-Power Company, at Ogden, Utah. Second series. Discussion of paper by Charles D. Marx, Charles B. Wing, and Leander M. Hoskins. 12500 w. Pro Am Soc of Civ Engs—April, 1900. No. 33807 E.

On the Flow of Water Over Dams. George W. Rafter. Presents a collection of new facts obtained during investigations as to the water supply for summit-level canals in the State of New York. Gives points from Bazin's papers, and experimental data from Cornell Univ. and other sources, showing the erroneous use of sharp-crested weir formulas for computing the flow over weirs of all shapes. Ill. 18600 w. Pro Am Soc of Civ Engs—March, 1900. No. 33306 E.

Locks.

The Dutton Pneumatic Balance Locks for Canals. Chauncey N. Dutton. Illustrated description of the characteristic features of these locks, and their operation. 8500 w. Jour Fr Inst—April, 1900. No. 33341 D.

Metal Protection.

See Civil Engineering, Construction.

Niagara.

Discharge Measurement of the Niagara River at Buffalo, N. Y. Discussion of paper by Clinton B. Stewart. 7000 w. Jour W Soc of Engs—Feb., 1900. No. 33340 D.

Nicaragua.

An Assumed Inconstancy in the Level of Lake Nicaragua; a Question of Permanency of the Nicaragua Canal. C. Willard Hayes. Undertakes to answer the questions raised in a recent paper by Angelo Heilprin, and claims the region is favorable for the proposed canal. 2200 w. Nat Geog Mag—April, 1900. No. 33473 C.

Panama Canal.

The Panama Canal (Le Canal de Panama). A. Dumas. A historical sketch, with a general discussion of the plans of the new company. Serial. Part I. 5000 w. Génie Civil—April 7, 1900. No. 33593 D.

Pollution.

The Prevention of Water Pollution in New Jersey. Editorial discussion of recent legislation in New Jersey. 3000 w. Eng News—April 5, 1900. No. 33451.

Pollution of Streams, with Special Reference to the Chicago Drainage Channel. B. H. Colby. Discusses the contamination of streams and the serious results, especially considering what should be done in St. Louis. Refers to the danger from the Chicago drainage channel, and urges filtration. 4200 w. Jour Assn of Engng Socs—Feb., 1900. No. 33337 C.

Power Development.

Construction of the Shawinigan Water and Power Company's Plant. Illustrated description of the hydraulic works to develop 60,000 horse-power at Shawinigan Falls. The coffer dam details were unusual on account of the great current at the site. 5000 w. Eng Rec—April 28, 1900. No. 33877.

The Niagara Falls Hydraulic Power and Manufacturing Company. A. Scheufelen. A well illustrated description of the canal and the power-house below the falls, with remarks on the industries to which the power is applied. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 17, 1900. No. 33554 D.

Pressure.

Plant for Increasing the Pressure at Ostrawa, Moravia (Druckerhöhungsanlagen in Mähr-Ostrau). K. Czerwenka. Illustrated description of an economical method of increasing the pressure by one atmosphere at a small water-works. 800 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1900. No. 33529 G.

Protective Device.

New Method of Diminishing the Force of Waves and Surf. An invention consisting of a floating net, retained on the surface of the water by outriggers, or by buoys. Ill. 1100 w. U. S. Cons Repts, No. 705—April 16, 1900. No. 33446 D.

Pumping Plant.

The Auxiliary Hydraulic Pumping

Plant of the Peoria Water-Works Co., Peoria, Ill. Dabney H. Maury, Jr. Illustrated detailed description of the plant, with account of the tests and operation. 4000 w. Eng News—April 26, 1900. No. 33821.

Riparian Rights.

An Important Decision Upon a Mill Owner's Suit to Collect Damages for Diversion of Water. Letter from Louis L. Tribus concerning the Newton case, with Judge Dixon's opinion. 2200 w. Eng News—April 5, 1900. No. 33452.

Rivers.

River Hydraulics. Continued discussion of paper by James A. Seddon. 3000 w. Pro Am Soc of Civ Engs—March, 1899. No. 33308 E.

Springs.

The Development of Springs at Fayetteville, Tenn. Describes the methods adopted in developing a number of sandrock springs for the supply of a town of 3000 people. 1000 w. Eng Rec—April 21, 1900. No. 33741.

Water Supply.

Mr. J. R. Freeman's report on the New York Water Supply. Illustrated review of a report showing that there were serious errors in the assumed discharge of the old and new Croton aqueducts and in the run-off of the Croton River watershed; the records of the latter have previously been accepted as correct and ranked among the most important waterworks data. Also expresses doubt as to any early reduction in water waste. 1800 w. Eng Rec—April 14, 1900. Serial. 1st part. No. 33654.

The Water Waste and Water Supply of New York City. Review of the report of John R. Freeman, with editorial notes. 8500 w. Eng News—April 19, 1900. No. 33728.

Water-Works.

New Water-Works, Latrobe, Pa. Illustrated description of a pumping plant with unusually complete piping for a small station, a reservoir, with concrete and brick lining, and a by-pass for pumping around and much higher than the reservoir to obtain extra head in case of fire. 1200 w. Eng Rec—March 31, 1900. No. 33323.

Progress on the New Water-Works for Cincinnati, O. Illustrated account of interesting work now in progress to pump water from the Ohio River to settling basins. 1300 w. Eng News—April 26, 1900. No. 33822.

The Disaster to the Water-Power Plant at Hannawa Falls, N. Y. Brief description of the works and the damage caused, with illustrations. 1200 w. Eng News—April 26, 1900. No. 33826.

MATERIALS.

See also Architectural Engineering, Construction.

Brick Testing.

A Method of Comparing Rattler Tests of Paving Brick. Daniel B. Luten. Illustrates and describes several rattlers, and discusses the value of the test. Also explains method of comparing. 2800 w. Munic Engng—April, 1900. No. 33345 C.

Paving Brick Tests. W. K. Hatt. Letter, with diagram, on the influence of moisture on the results of brick tests by the rattler method. 500 w. Eng Rec—April 7, 1900. No. 33426.

Building Stones.

Building Stones and Stone Cutting. Alexander Marshall. Read before the Toronto Chapter, Ontario Assn. of Archts. Suggestions concerning the choice of building stone, and the kinds most used, with remarks on stone-cutting. 2200 w. Stone—April, 1900. No. 33639 C.

Cement.

New Works of the William Krause & Sons Cement Company. Horace DeK. Haight. Illustrates and describes a plant of 600 bbls. capacity, in which the power-transmission apparatus received particular attention. 2500 w. Eng Rec—March 31, 1900. No. 33326.

Progress Report of the Special Committee on the Proper Manipulation of Tests of Cement. 21500 w. Pro Am Soc of Civ Engs—April, 1900. No. 33802 E.

Refractory Linings for Rotary Portland-Cement Kilns. Edward Duryea. Explains the making of linings lasting much longer than those of the usual composition. 1000 w. Eng Rec—March 31, 1900. No. 33325.

Concrete.

Armored Concrete. A résumé of results obtained in recent trials of this material, with discussion of the conclusions reached. 1900 w. Engr, Lond—March 30, 1900. No. 33617 A.

Corrosion.

Paints and Varnishes. A. H. Sabin. Considers methods for the protection of iron, describing briefly the pigments used for preservative paints. 5500 w. Jour Assn of Engng Socs—Feb., 1900. No. 33-338 C.

See also Metal Protection, under Civil Engineering, Construction.

Mortar.

Mortar. Gustave W. Drach. Read at meeting of the Cincinnati Chapter of Architects. The history of the use of this material is given and the various kinds of mortars discussed. 2500 w. Stone—April, 1900. No. 33638 C.

Shale.

The Origin, Properties, and Uses of Shale. H. Ries. Discusses principally the properties. 2000 w. Stone—April, 1900. No. 33640 C.

Shock Elasticity.

An Example of Elasticity and Tenacity Under Sudden Blows (Eine Aufgabe aus der Stosselastizität und-festigkeit). F. Leitzmann. A mathematical discussion of the shock elasticity of steel, based on the bending of wheel axles in railroad practice. Serial. Part I. 1800 w. Zeitschr d Ver Deutscher Ing—March 31, 1900. No. 33560 D.

Testing Laboratory.

Report on the Work of the Royal Technical Testing Laboratory, Berlin, for the Year 1898-99 (Bericht über die Thätigkeit der Könglichen Technischen Versuchsanstalten im Etatsjahre, 1898-99). Record of the tests conducted at this institution, of metals, building materials, paper, oils, and list of chemical analyses. 5200 w. Mitt aus d Kgl Tech Versuchsanst—No. 6, 1899. No. 33526 G.

MUNICIPAL.

See also Civil Engineering, Construction.

Auxiliary Pipes.

Auxiliary Pipe Systems for Extinguishing Fires. Editorial on the inadequacy for fire-extinguishing purposes of the pressure in the small pipe systems. Suggested by the recent fire at Greenpoint, N. Y. 700 w. Eng News—April 19, 1900. No. 33726.

Cleaning.

Municipal Cleansing in Great Britain. Reviews interesting details of English practice as set forth in a recent report of the Assn. of Cleansing Supts. of Gt. Britain. 2600 w. Eng News—April 26, 1900. No. 33824.

Garbage.

Garbage Cremation in New York. Shows that the discontinuance of cremation was due to local conditions of haul and not to failure of destructors. 500 w. Eng Rec—March 31, 1900. No. 33320.

Notes on Garbage Disposal at Cincinnati, Ohio. Brief account of the system employed. 1200 w. Eng News—April 26, 1900. No. 33823.

Pavements.

Smoothness of Pavements. Daniel B. Luten. Illustrated description of examinations made of various kinds of pavements in Lafayette, Ind. 3000 w. Eng Rec—March 31, 1900. No. 33322.

See also Sidewalks.

Sewage.

English Experiments on the Bacterial Treatment of Sewage, with an Account of the Work Done at Manchester, England, During the Past Year. Leonard P. Kinnicutt. Reviews briefly the experimental study of this subject, giving the history of sewage treatment at Manchester, where what is known as the double contact system has been carefully studied. Ill. 13000 w. Jour Assn of Engng Socs —Feb., 1900. No. 33336 C.

Purification of Sewage by Means of the Soil. George Janin. Discusses the experiments and conclusions regarding the purification by the soil and agricultural utilization of sewage, the operation and rules, giving report of the sewage farm of St. Laurent College. Ill. 5400 w. Can Soc of Civ Engs—Adv. Brief—April 12, 1900. No. 33761 D.

Sewage Disposal by Intermittent Filtration at Leicester, Mass. Information concerning this plant, which seems to be giving satisfaction, and of the character of the sewage. 1400 w. Eng News—April 5, 1900. No. 33455.

The Bacteriological Treatment of Sewage. H. T. Scoble. Read at meeting of the Surveyor's Inst., London. Reviews and discusses the various processes now in use. General discussion. 1400 w. San —April, 1900. No. 33369 D.

The International System of Bacterial Sewage Treatment. Explains works at Southwold and Reigate, England, in which sewage is distributed by revolving arms over filters containing polarite. At Southwold there is also a preliminary filtration through anaerobic beds. 1800 w. Eng Rec—April 7, 1900. No. 33421.

The Filtering Beds of Brandenburg, Prussia (Die Rieselfeldanlage der Stadt Brandenburg a. H.). E. Bernhard. A brief description of the large field of over 250 acres to which the sewage from Brandenburg is led for filtration. 400 w. 1 plate. Gesundheits Ing—March 31, 1900. No. 33521 B.

The Sewerage of Ealing, England. James H. Fuertes. Describes a system of treatment involving the use of lime, clay and sulphate of alumina, with the cremation of the sludge. 700 w. Eng Rec—April 21, 1900. No. 33735.

The Worcester Sludge Process. Illustrated description of the largest sewage filter press plant in the United States. 1400 w. Eng Rec—April 21, 1900. No. 33736.

Sewage Disposal in New Jersey. Review of two decisions of the court of final jurisdiction permitting the discharge of sewage into streams, subject only to the payment of damages to riparian owners along the non-tidal portions of the rivers. 900 w. Eng Rec—March 31, 1900. No. 33319.

Sewerage.

The New Jersey State Sewerage Commission. Explains the power of a commission which has been given practically absolute control over the sewerage and sewage disposal systems of New Jersey. 900 w. Eng Rec—April 7, 1900. No. 33416.

Sewer Work at Woonsocket, R. I. Illustrated description of inverted siphons, weir, manholes and tunneling operations. 600 w. Eng Rec—March 31, 1900. No. 33324.

The Sewerage of Frankfort-on-the-Main. J. H. Fuertes. Illustrates and describes details of the sewers, which are particularly well constructed. 1200 w. Eng Rec—April 14, 1900. No. 33658.

The Sewerage Problem of the City of Worcester, Mass. An explanation of the topography of the city and the existing conditions, with an illustrated description of the plant now in operation, on the chemical precipitation system. 1600 w. Sci Am Sup—April 7, 1900. No. 33411.

Sewers.

Cleaning Sewers. Elmer D. Fletcher. A discussion of the merits of various methods. 1300 w. Eng Rec—April 7, 1900. No. 33425.

Sidewalks.

Some Theories Regarding Cement Walks. Daniel B. Luten. Illustrated description of different classes of failure in walks and methods of avoiding them. 3300 w. Eng Rec—April 14, 1900. No. 33657.

See also Pavements.

Water Supply.

See Civil Engineering, Hydraulics and Water Supply.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A United States Government Pacific Cable. George Owen Squier. Discusses the need, practicability, routes, stations, and various subjects relating to the enterprise, giving plates, maps, etc. 10000 w. Jour U. S. Art—March-April, 1900. No. 33626 D.

The Pacific Cable. Opinions in the Canadian House of Commons. 4500 w. Elec Rev, Lond—March 30, 1900. No. 33614 A.

Multiplex Telegraphy.

A Tele-Microphone Differential Relay in a Multiplex-Telegraphy System (Sur la Télégraphie Multiplex Relai Telemicrophonique Différentiel). E. Mercadier. An illustrated description. 600 w. Comptes Rendus—March 19, 1900. No. 33584 D.

Printing Telegraphs.

Printing Telegraphs (Ueber Ferndrucker). Dr. Raps. An address delivered before the Electrotechnical Society, of Berlin, giving a particular description of the Siemens and Halske apparatus, with a general historical sketch of the subject; with illustrations. 3000 w. Elektrotech Zeitschr—April 12, 1900. No. 33518 B.

Space Telegraphy.

Novelties in Receiving Apparatus in Wireless Telegraphy (Sur l'Emploi de Nouveaux Radio-conducteurs pour la Télégraphie sans Fil). C. Tissot. Filings of magnetic and non-magnetic substances were used in the coherer, which was placed in a magnetic field parallel with the lines of force, with good results as regards reliability. 600 w. Comptes Rendus—April 2, 1900. No. 33585 D.

The Auto-Decohering of Carbon and Its Application in a Telephonic Receiver for Wireless Telegraphy Signals (Sur l'Auto-Decohération du Charbon. et sur l'Application de cette Découverte aux Appareils Téléphoniques pour Recevoir les Signaux de la Télégraphie sans Fils). Thomas Tounnasina. A carbon powder receiver. 600 w. Comptes Rendus—April 2, 1900. No. 33586 D.

See also Coherer under Electro-Physics.

Telegraphs.

A Model Telegraph Plant. G. H. Page. Brief illustrated description of a plant at Oelwein, Ia. 600 w. Elec Rev, N. Y.—April 18, 1900. No. 33744.

Telegraph-Telephone.

Simultaneous Telegraphy and Telephony on One Wire; with Special Reference to the Operation of the Berlin Fire Department (Gleichzeitiges Telegraphiren und Telephoniren ouf einer Leitung, besonders im Betriebe des Berliner Feuerwehr). F. Walloch. An address delivered before the Hanover Electrotechnical Society, describing the system used in the Berlin Fire Department, with illustrations. 2000 w. Elektrotech Zeitschr—March 22, 1900. No. 33508 B.

Telephones.

Ducousso Telephone Switchboards (Tableaux Téléphoniques Ducousso). L. Moutillot. An illustrated description of a switchboard designed to prevent the operator from hearing the conversation.

Also, of another switchboard, without this feature. 1700 w. L'Electricien—March 24, 1900. No. 33587 B.

Toll-Lines.

Design of the L. M. and B. H. System. H. P. Clausen. Illustrated detailed description of this system, discussing the signaling service. 3200 w. Tel Mag—April, 1900. No. 33787.

DISTRIBUTION.

Alternating Currents.

Formulæ for Calculating the Drop in Alternating-Current Conductors (Formeln zur Berechnung des Spannungsabfalls in Wechselstromleitungen). Dr. L. Fleischmann. Formulæ giving the exact determination of the drop. 600 w. Elektrotech Zeitschr—March 29, 1900. No. 33511 B.

The Production of Asymmetrical Alternating Currents by Means of Electrolytic Polarization. W. L. Hildburgh. Deals only with asymmetrical conductors whose action depends on counter e. m. fs. produced by electrolysis. 3500 w. Elec Wld & Engr—April 14, 1900. Serial. 1st part. No. 33666.

Equalizers.

The Calculation of Lighting-Circuit Regulators (Beitrag zur Berechnung von Lichtleitungs-Regulatoren). E. Stadelmann. An article giving formulæ and curves for calculating the resistance for equalizing the pressure in electric lighting circuits. 1600 w. Elektrotech Zeitschr—April 12, 1900. No. 33517 B.

Hunting.

Hunting of Alternating Current Apparatus. H. W. Buck. Explains what the phenomenon of hunting is, the cause, and the laws which govern it, with related matter. Ill. 1800 w. Elec Wld & Engr—April 7, 1900. No. 33494.

Polyphase.

Some Work with Polyphase Apparatus. J. L. Thomas. Illustrates and describes the plant operated by the Consolidated Lighting Co., of Montpelier, Vt., and the satisfactory working of the three-phase apparatus. 1300 w. Elec Wld & Engr—April 14, 1900. No. 33663.

The Polyphase Distributing System of the Metropolitan Street Railway Company of New York City. J. E. Woodbridge. Begins an illustrated description of the power generating equipment of the largest railway power plant in the world. 1400 w. Elec Wld & Engr—March 31, 1900. Serial. 1st part. No. 33354.

A Polyphase Power Plant. Frank C. Perkins. Brief illustrated description of the Montana Power Company's station on Big Hole River. 700 w. Elec Rev, N. Y.—April 18, 1900. No. 33746.

Rotary Currents.

The Wave Form of the Rotary Current (Ueber die Wellenform des Drehstromes). O. S. Bragstad. A mathematical discussion, with an experimental determination of the theory developed. Diagrams and formulæ. 2400 w. Elektrotech Zeitschr—March 29, 1900. No. 33510 B.

Works-Distribution.

Electric-Power Distribution. An illustrated description of the works of the Westinghouse Air Brake Company. 3000 w. Am Engr & R R Jour—April, 1900. No. 33317 C.

ELECTRO-CHEMISTRY.

Accumulators.

New Active Material for Accumulators (Neue Akkumulatoren-Masse). A rather indefinite account of a new active material which it is claimed will obviate the use of plates. 500 w. Elektrochemische Zeitschr—April, 1900. No. 33503 G.

Cells.

Energy Losses in Galvanic Cells—Their Cause and Prevention. J. Warren. The first of a series of articles aiming to investigate the various causes detracting from the efficient working of the cells. 1500 w. Elec, Lond—April 13, 1900. Serial. 1st part. No. 33768.

Two New Forms of Mercury Cell for the Electrolytic Production of Alkalies and Chlorine. John B. C. Kershaw. Illustrates and describes two new forms in which mechanical movements are dispensed with, and the forces of gravitation effect the removal of the amalgam from the cells. 1500 w. Elec Rev, Lond—April 13, 1900. No. 33798 A.

Chlorates.

The Electrolytic Preparation of Chlorates (Ueber Elektrolytische Chloratdarstellung). John Laudin. Abstract of a paper read before the Swedish Engineers' Society, Stockholm. 1500 w. Zeitschr f Elektrochemie—March 22, 1900. No. 33564 G.

Conductivity.

Investigation of the Conductivity of Dilute Solutions of Double Salts (Verfahren zur Ermittelung des Leitungsvermögens Mässig mit Wasser Verdünnter Doppelsalzlösungen). J. G. MacGregor and J. H. Archibald. An account of experiments, with tables showing the observed and calculated values. 3000 w. Elektrochemische Zeitschr—April, 1900. No. 33504 G.

Electro-Engraving.

Electro-Gravures (Elektrogravüre). Josef Rieder. A long illustrated description of the author's new method of etching steel. 7000 w. Elektrochemische Zeitschr—April, 1900. No. 33502 G.

Reactions.

The Action of Carbon Upon Refractory Oxides at High Temperatures. Alec. A. Beadle. On some of the reactions that occur when subjecting metals (or non-metals) to reduction with carbon at the high temperatures obtainable in the electric furnace. 2000 w. Elec Rev, Lond—April 13, 1900. No. 33799 A.

Sodium.

On Electrical Effects Due to Evaporation of Sodium in Air and Other Gases. W. Craig Henderson. Communicated to the Royal Soc. An account of experiments to determine whether evaporation of an unelectrified liquid produces any electrification. 800 w. Elect'n, Lond—April 6, 1900. No. 33691 A.

Storage Batteries.

Storage Battery Problems. E. J. Wade. Read before the Inst. of Elec. Engs. A discussion of some of the theoretical and chemical questions connected with the lead cell. Also editorial. 8000 w. Elect'n, Lond—March 23, 1900. Serial. 1st part. No. 33378 A.

ELECTRO-PHYSICS.

Apparatus.

Arrangement for Drawing Off the Gas from Electrolytic Apparatus with Horizontal Electrodes (Gasabzugs-Einrichtung für Elektrolytische Apparate mit Wesentlich Horizontal Angeordneten Elektroden). W. Bein. An illustrated account of apparatus patented in Germany. 600 w. Zeitschr f Elektrochemie—March 29, 1900. No. 33565 G.

Coherer.

Investigations Into the Method of Operation of the Coherer (Untersuchungen über die Wirkungsweise des Fritters). J. Härdén. An examination of coherers under the microscope, to determine how the resistance is lowered. 1000 w. Elektrotech Zeitschr—April 5, 1900. No. 33515 B.

Some New Coherer Phenomena. F. Companile and G. di Ciommo. Abstract translation of article in *L'Elettricita,* describing experiments undertaken to obtain information as to the nature of coherer action. Ill. 900 w. Elec Rev, N. Y.—April 4, 1900. No. 33412.

Electrolytes.

Are Rarefied Gases Electrolytes? M. E. Bouty. Read before the Société Francaise de Physique. Describes investigations of the writer and gives results. 2000 w. Elect'n, Lond—March 23, 1900. No. 33379 A.

Hysteresis.

Hysteresis in Sheet Iron and Steel. Arthur Hillyer Ford. An account of researches on commercial transformers, undertaken with the object of showing the conditions met in practice. Also on small specimens of iron obtained from various makers and users. 1800 w. Trans Am Inst of Elec Engs—March, 1900. No. 33769 D.

Interrupter.

A Working Form of Wehnelt Interrupter. Weston A. Price. Illustrated description. 450 w. Elec Rev, N. Y.—April 11, 1900. No. 33630.

Magnetic Properties.

On the Difference Between Constant and Variable Magnetization (Ueber den Unterschied zwischen Stetiger und Unstetiger Magnetisirung). E. Gumlich and Erich Schmidt. A contribution from the National Laboratory in Berlin, giving the results of experiments, with tables. 1300 w. Elektrotech Zeitschr—March 22, 1900. No. 33505 B.

Magnetic Separation.

The Principle of Electromagnetic Separation (Das Elektromagnetische Aufbereitungsprinzip). E. Langguth. A theoretical discussion. 3300 w. Zeitschr f Elektrochemie—April 5, 1900. No. 33-566 G.

Rontgen Tube.

A New Röntgen Tube with Ernst Pabst's Anti-cathode (Ueber eine Neue Röntgenröhre mit Ernst Pabst's Anti-Kathode). F. Kurlbaum. Showing the advantage of coating the anti-cathode with platinum black, which has high emissive power and so keeps down the temperature. 700 w. Elektrotech Zeitschr—March 22, 1900. No. 33507 B.

Thermo-Electricity.

Thermo-Electricity (Ueber Thermoelektricität). C. Liebenow. An address delivered before the Electrotechnical Society, Berlin. Principally theoretical, giving a formula for thermo-e. m. f. 4000 w. Elektrotech Zeitschr—March 22, 1900. No. 33509 B.

GENERATING STATIONS.

Accumulators.

The Charging of Accumulators at Constant Pressure (Ueber die Ladung von Akkumulatoren bei Konstanter Spannung). C. Heim. A paper presented at a meeting of the German Electrical Engineers' Association in Hanover, containing a long discussion of the subject, with tables and curves. Serial. Part I. 3200 w. Elektrotech Zeitschr—April 5, 1900. No. 33514 B.

Bolton.

Bolton Corporation Combined Lighting and Traction Works. Illustrated detailed description. 1800 w. Elect'n, Lond

—March 30, 1900. Serial. 1st part. No. 33612 A.

Brushes.

The Boudreaux Laminated Brushes at Low Voltages (Die Boudreaux-Blætterbuerste bei Niederer Spannung). Dr. G. Langbein. An article showing the disadvantage of using brushes made of anti-friction metal on low voltage dynamos, on account of their high resistance. 700 w. Elektrotech Zeitschr—March 22, 1900. No. 33506 B.

Hydraulic Generation.

Direct-Connected Waterwheels and Generators. Frank C. Perkins. Illustrates and describes examples of the use of impulse-wheels, and pressure turbines for direct-connection with electrical generators, with remarks on efficiency. 1300 w. W Elect'n—April 14, 1900. No. 33-676.

Lausanne.

The Electric Plant of the City of Lausanne (Les Installations Eléctriques de la ville de Lausanne). An account of the plant now being constructed for this Swiss city. Power is derived from the Rhone and the current led 35 miles to the city. 1200 w. Schweiz Bauzeitung—March 24, 1900. No. 33537 B.

Machinery.

650 K. W. Ferranti-Plenty Plant. Illustrated description of the latest unit which has been added to the equipment of the central station of the London Electric Supply Corporation at Deptford, Eng. 2300 w. Engr, Lond—April 13, 1900. No. 33780 A.

Multipolar.

Advantages of Multipolar Construction. Alton D. Adams. Compares the multipolar and bipolar machines, discussing the advantages of the former. 2700 w. W Elect'n—April 14, 1900. No. 33-675.

Niagara Power.

New Wheel Pit of the Niagara Falls Power Co.'s Power Plant at Niagara Falls, N. Y. O. E. Dunlap. Information concerning this work, which when completed will give this company a total of 105,000 H. P. Ill. 1200 w. Eng News—April 5, 1900. No. 33453.

The Work of the Tonawanda Power Company. Illustrates and describes the transforming of Niagara power for motors, converting it for railway use, and regenerating it for arc and incandescent lighting. 4200 w. Am Elect'n—April, 1900. No. 33402.

Operation.

Operation of Electric-Lighting Plants from a Business Standpoint. A. E. Judge. Read before the Southwestern Gas, Electric, and Street Railway Assn. Discusses in detail the need of guarding against accident, stoppage, etc., accounts, employees, expenses, prices, etc. 1700 w. Am Gas Lgt Jour—April 23, 1900. No. 33766.

Paris Exposition.

The International Central Station at the Paris Exposition (Mittheilungen über die Internationale Electricitätsstation in der Weltausstellung Paris, 1900). Dr. O. Fauerlain. An illustrated description of the great international generating plant on the Champ de Mars, with an output of over 20,000 kw. 2000 w. Elektrotech Zeitschr—April 12, 1900. No. 33516 B.

Power Plant.

The Electrical Power Plant of the Armour Packing Houses in Chicago. Stephen H. Goddard. Brief illustrated description of an isolated plant. 1500 w. Elec Rev, N. Y.—April 25, 1900. No. 33846.

See also Power Station under Street and Electric Tramways.

Rates.

Methods of Charging for Public Supply of Electricity. W. W. Lackie. Abstract of a paper read before the Glasgow Section of the Inst. of Elec. Engs. Discusses the methods at present in use, and the basis on which they were founded, and the means of securing a uniform rate. 2500 w. Elect'n, Lond—April 6, 1900. No. 33690 A.

Station.

Large Central Station for Denver, Col. J. W. Dickerson. Information concerning a new station for supplying electric light to the entire city, the cost, etc. 1400 w. Elec Wld & Engr—April 21, 1900. No. 33765.

Some Statistics Relating to Electric Power Production. Philip Dawson. The first of a series of articles showing the importance of properly laying out and working electrical stations, comparing various systems and the practice in different countries. 1800 w. Engng—April 6, 1900. Serial. 1st part. No. 33-697 A.

Storage Batteries.

Advantages of Storage Batteries in Power Houses (Wirkungen und Vortheile von Pufferbatterien in Bahnbetrieben). A short article on the advantages of storage batteries for small power houses with varying loads. 700 w. Ill. Zeitschr f Klein u Strassenbahnen—March 16, 1900. No. 33577 C.

Supply Works.

Doncaster Electricity Supply Works. Part first gives an account of the town, and begins an illustrated description of the works. 1600 w. Elec Engr, Lond—

April 6, 1900. Serial. 1st part. No. 33692 A.

Greenock Corporation Electricity Works. Illustrated detailed description of these works, and also of the Babcock and Wilson chain grate stoker and steam superheater in use. 2800 w. Elec Rev, Lond—March 30, 1900. No. 33613 A.

The Willesden Electricity Works of the Metropolitan Electric Supply Company, Limited. Illustrated description of an important plant. 2400 w. Elec Rev, Lond—March 23, 1900. Serial. 1st part. No. 33381 A.

York Electricity Supply Works. An outline history of the electric-lighting scheme, with illustrated technical description of the plant installed. 2500 w. Elec Eng, Lond—March 23, 1900. Serial. 1st part. No. 33380 A.

LIGHTING.

Car Lighting.

Electric Lighting on Prussian Railway Postal Cars. From *Der Electro-Techniker.* Information relating to the advantages of using the electric light on postal cars, and the success which has led to the decision to use it on all such cars in Prussia. 1800 w. R R Car Jour —April, 1900. No. 33649.

Combination.

Combined Engine and Dynamo. Brief illustrated description of the combined engines and dynamo of the Hull Electric Lighting Station. 900 w. Engr, Lond—March 23, 1900. No. 33397 A.

Enclosed Arcs.

Arc Lighting (L'Eclairage par Arc). A. Bochet. A general article, with special attention to enclosed arcs. 1900 w. Génie Civil—March 17, 1900. No. 33590 D.

Gas Coke.

Gas Coke for Electric Lighting. Alton D. Adams. A comparison of the values of the gas and of the electric energy that may be derived from coke. 2000 w. Elec Wld & Engr—April 28, 1900. No. 33892.

Lamps.

Incandescent Lamps. Francis W. Willcox. Describes in detail some of the important and interesting features in the development. Ill. 4800 w. Jour Fr Inst —April, 1900. Serial. 1st part. No. 33343 D.

St. Petersburg.

The Electric Lighting of St. Petersburg. An illustrated description of the station and network of the Electricité et Hydraulic de Charleroi Company. 1200 w. Elec Rev, Lond—April 6, 1900. Serial. 1st part. No. 33693 A.

Train Lighting.

Dick's System of Electric Lighting for Trains (Dick's Elektrische Zugsbeleuchtung). L. Kohlfürst. An illustrated account of this system, which derives current from a dynamo geared to the car axle, with comparisons of the cost with that of other systems of train lighting. 2000 w. Schweiz Bauzeitung—March 31, 1900. No. 33538 B.

MEASUREMENT.

Alternating Currents.

The Use of Hot-Wire Shunt Instruments as Alternating Ammeters. E. A. Wagner. Explanation of method. 600 w. Am Elect'n—April, 1900. No. 33403.

Alternating Curves.

A New Method of Tracing Alternating Curves. Discussion of paper by Fitzhugh Townsend. 4500 w. Trans Am Inst of Elec Engs—March, 1900. No. 33770 D.

Charges.

Commercial Electrical Measurements and Prices. William D. Marks. Explains a simple system for determining the cost and selling price of electricity. 3200 w. Elec Wld & Engr—April 28, 1900. Serial, 1st part. No. 33891.

Dynamometer.

An Electric Brake Dynamometer (Ein Elektrisches Bremsdynamometer). Prof. A. Grau. An illustrated description of a dynamometer in which the braking effect is due to a copper disc rotating in a magnetic field. 1200 w. Elektrotech Zeitschr —April 5, 1900. No. 33512 B.

Electric Waves.

Application of the Radio-Micrometer to the Measurement of Short Electric Waves. G. W. Pierce. An illustrated description of an apparatus found to be useful in quantitative experiments on electric waves. 2300 w. Am Jour of Sci —April, 1900. No. 33344 D.

Measurements.

Electrical Measurements. John Hertner. Makes comparison of the action of current in a wire with the flow of water in a pipe, explains the fundamental units, etc. 2000 w. Engr, U. S. A.—April 15, 1900. No. 33747.

Standards.

Electrical Standards. Frank A. Wolff, Jr., in *Science*. Concerning the facilities afforded by the office of standard weights and measures for the verification of electrical standards and electrical measuring apparatus. 2200 w. Elec Rev, N. Y.— April 4, 1900. Serial. 1st part. No. 33413.

Station Tests.

Portable Direct Current Measuring Instruments for Station Tests. Harris J. Ryan and E. L. West. Part first treats of the details of construction of direct-current instruments. Ill. 5000 w. Sib Jour of Engng—April, 1900. Serial, 1st part. No. 33809 C.

Testing.

Differential Testing with Single-Coil Instruments. George T. Hanchett. Illustrates and describes methods of measuring. 800 w. Am Elect'n—April, 1900. No. 33404.

POWER APPLICATIONS.

Controller.

A Regenerative Controller. John C. Henry. Describes the development of the controller, giving a diagram of connections and tabulated results of comparative tests, and notes the suitability of this method of control for automobiles. 1000 w. Elec Wld & Engr—March 31, 1900. No. 33355.

Cranes.

New Electric Cranes (Neuere Elektrische Hebezeuge). An illustrated account of some new electric cranes and their details. 1500 w. Zeitschr d Ver Deutscher Ing—March 31, 1900. No. 33559 D.

Electrical Driving.

Electrical Driving of Factories from the Public Point of View. Alfred H. Gibbings. Read before the Northern Soc. of Elec. Engs., Manchester, Eng. Gives tabulated list showing the extent to which the electric motor has been adopted in England, with remarks on the economy effected. 3500 w. Elec Rev, Lond—March 30, 1900. No. 33615 A.

Induction Motors.

Notes on Single-Phase Induction Motors and the Self-Starting Condensing Motor. Discussion of paper by Charles Proteus Steinmetz. 500 w. Trans Am Inst of Elec Engs—March, 1900. No. 33771 D.

Mill Power.

Induction Motors at Lancaster Mills. Frank C. Perkins. Illustrates and describes the electric motors installed in mills at Clinton, Mass., stating some of their advantages. 900 w. W Elect'n—March 31, 1900. No. 33359.

Mining Plant.

Electric Power and Lighting Plant at the Hollertszug Iron Mine, near Herdorf, Germany (Elektrische Kraftübertragungs und Beleuchtungsanlage der Eisenerzgrube "Hollertszug" bei Herdorf an der Sieg). C. Pfankuch. An illustrated description of this plant, in which the current is applied in various ways. 2000 w. Ill. Zeitschr f Klein u Strassenbahnen—April 1, 1900. No. 33578 C.

Electrically Driven Machinery Used in Sinking a Shaft at the Rheinelbe and Alma Mine, Germany (Elektrisch Angetriebene Maschinen beim Abtenfen des Schachtes Rheinelbe II., der Zeche Vereinigte Rheinelbe und Alma). Illustrated description of the electric plant for driving the shaft-sinking machinery and pumps. 2000 w. 2 plates. Glückauf—April 7, 1900. No. 33572 B.

Power.

Power Development from the Drainage Canal. A statement of the plans for utilizing the 20,000 H. P. afforded by the Chicago Canal. 600 w. Eng Rec—April 7, 1900. No. 33417.

Rotaries.

A Means of Fixing the Frequency of Inverted Rotaries. Describes an ingenious arrangement for preventing rotary converters, deriving their power from a source of direct current and generating alternating current, from fluctuating in speed when their field strength is affected by variations of the power factor of the alternating-current output. 1800 w. Elec Wld & Engr—April 7, 1900. No. 33492.

Rotary Transformers (Ueber rotirende Umformer). H. S. Meyer. An article on the practical application of these machines, with diagrams. 1700 w. Elektrotech Zeitschr—April 5, 1900. No. 33513 B.

Storage Batteries.

The Use of the Storage Battery in the Theatre. On the advantages and adaptability of storage batteries. 1500 w. Am Elect'n—April, 1900. No. 33405.

Tool Driving.

Electric Driving for Heavy Machine Tools. Statements of power found by direct experiment to be absorbed by certain heavy machine tools, with diagrams. The investigations were made at the Atlas Works, Sheffield. 2000 w. Engr, Lond—March 23, 1900. No. 33396 A.

TRANSMISSION.

California.

Electric Power Transmissions of Southern California. Map and facts of interest concerning the sections covered, routes, methods of securing reliability in the service, etc. 2300 w. Jour of Elec—March, 1900. No. 33671.

Duluth.

Power Transmission Schemes at Duluth, Minnesota. Frank W. Springer. Considers the schemes for utilizing as water power the St. Louis and the Black rivers. Ill. 1300 w. Elec Wld & Engr—April 14, 1900. No. 33664.

Electric Power.

The Basis of Electric Power Transmission. R. B. Williamson, W. B. Potter, M. G. Starrett, R. L. Russell, and W. B.

Reed. Interesting addresses, with illustrations. 15000 w. N. Y. R R Club—Feb. 15, 1900. No. 33487.

Long-Distance.

The Limitations of Long-Distance Power Transmission. W. E. Goldsborough. Considers the success attained in this field and various matters relating to the development, predicting that power can be delivered at distances of 500 miles from the generating station. 1500 w. Elec Rev, N. Y.—April 18, 1900. No. 33745.

Phono-Electric Wire.

New Wire for Trolley and Other Purposes. F. Z. Maguire. Gives a report of tests showing the fundamental properties of phono-electric wire, a comparison with other wires, and the claims made for this new material. 800 w. Elec Rev, Lond—April 6, 1900. No. 33694 A.

Polyphase.

See same title under Street and Electric Tramways.

MISCELLANY.

Berlin.

The Position and Development of the Electro-technical Industry in Berlin, in 1900 (Die Lage und Entwickelung der Elektrotechnischen Industrie Berlins im Jahre 1900). A general article, giving accounts of various applications of electricity. 2300 w. Die Elektrizität—March 17, 1900. 33568 C.

Military Uses.

Electrical Appliances in Military Operations. Capt. John P. Wisser. A most interesting illustrated exposition of the many uses to which electricity is put in the military field, with descriptions of the apparatus and of the method of its use. Ill. 4500 w. The Engineering Magazine—May, 1900. No. 33905 B.

Warfare.

Electricity in War. John Perry. An illustrated account of some of the work and training of the British Electrical Engineer Volunteer Corps. 2300 w. Nature—April 5, 1900. No. 33686 A.

GAS ENGINEERING

Acetylene.

The New Gaseous Illuminant, Acetylene, and Its Source of Production, Calcium Carbide. An account of the discovery of acetylene, its nature, cost, efficiency of any process, etc. 2500 w. Ind & East Engr—March, 1900. No. 33653 D.

Appliances.

Gas Appliance Exchanges. Fred R. Persons. Read at meeting of Ohio Gas Light Assn. Reasons why the sale of gas consuming devices should be separated from the gas industry proper. Discussion. 10000 w. Am Gas Lgt Jour—April 2, 1900. No. 33356.

Candle Power.

Address of J. W. Carmichael before the Glasgow meeting of Scottish Gas Managers. Discusses subjects of interest and importance and suggests that the illuminating power of gas in Scotland should be reduced to a uniform standard of twenty candles. Lengthy discussion. 10300 w. Gas Wld—April 7, 1900. No. 33689 A.

Freezing.

Dr. Bueb's Method of Preventing Freezing in Gas Services. Discusses this method, which consists in the addition of vaporized alcohol to the gas. 2000 w. Jour Gas Lgt—April 3, 1900. No. 33611 A.

Illumination.

A Simple Illumination Photometer. Describes interesting examples of modern illumination, and notes the need of a means of measuring. Illustrates and describes the construction of a simple photometer and the method of using. 2000 w. Sci Am Sup—April 14, 1900. No. 33683.

The Elements of Illumination. Louis Bell. Considers some of the fundamental principles, optical, physiological and æsthetic, which underlie the proper use of artificial illuminants, and how to adapt them to existing conditions. 2000 w. Elec Wld & Engr—April 14, 1900. Serial. 1st part. No. 33665.

The Production of Light by Electricity and Gas. Ed. C. de Segundo. A discussion of the relative merits of gas and electric lighting. 1800 w. Elec Rev, Lond—April 6, 1900. Serial. 1st part. No. 33695 A.

Inclined Retorts.

The Carbonization of Coal for the Production of Illuminating Gas. W. R. Herring. Read at the Edinburgh meeting of the Royal Scottish Soc. of Arts. Discusses the saving in labor and expense brought about by the application of the force of gravity to the charging of coal-gas retorts. 2800 w. Jour Gas Lgt—April 3, 1900. No. 33610 A.

Injurious Effects.

The Deterioration of Leather Bookbindings. Extract from a paper by Douglas Cockrell at a meeting of the London Soc. of Arts. The conclusion reached was that gas is not the chief cause of damage, that it is likely to be in some degree injurious is admitted, and the need of proper ventilation shown. 1500 w. Jour Gas Lgt—April 17, 1900. No. 33875 A.

London.

The Rise and Development of the London Gas Supply. W. J. Liberty. Read at meeting of the Gas Engineering Soc., London. Abstract. Reviews the history of the companies. 1800 w. Jour Gas Lgt—March 20, 1900. No. 33310 A.

Meters.

Prepayment Meters. John D. McIlhenny. Read at meeting of Ohio Gas Light Assn. A discussion of results, cost, etc. 5000 w. Am Gas Lgt Jour—April 9, 1900. No. 33486.

Naphthalene.

Estimation of Naphthalene in Coal Gas. Harold G. Colman and J. F. Smith. Paper read at meeting of the Nottingham Section of the Soc. of Chem. Ind. An explanation of a method devised by the writers. Ill. 2000 w. Jour Gas Lgt—March 27, 1900. No. 33444 A.

Naphthalene and Coal Gas. An interview with William Young, discussing the novel theory recently presented in a paper by R. W. Allen. 3000 w. Gas Wld—March 31, 1900. No. 33608 A.

Natural Gas.

Natural Gas. Southard Hay. Brief account of the geological conditions upon which the occurrence seems to depend, the simple machinery required for its storage and transmission, and the extent and convenience of its use. 2000 w. Yale Sci M—April, 1900. No. 33607 C.

Purification.

Some New Ideas About Oxide Purification. B. E. Chollar. Read at meeting of Ohio Gas Lgt. Assn. A short paper and lengthy discussion. 3800 w. Am Gas Lgt Jour—April 16, 1900. No. 33661.

Street Lighting.

Street Lighting. Andrew Hickenlooper. Address at meeting of the Ohio Gas Light Assn. Interesting historical review, with general discussion. 16800 w. Am Gas Lgt Jour—April 9, 1900. No. 33485.

Supply.

By-Product Coke Ovens as a Source of Gas Supply. Peter Young. Compares the cost of oven and retort plants, and gives information concerning the two coke-oven plants on the American continent supplying illuminating gas. Discussion. 3300 w. Am Gas Lgt Jour—April 16, 1900. No. 33662.

Underground Water.

The Law in Regard to Underground Water. J. Shiress Will. Read at meeting of the Surveyors' Inst., London. Reviews the English law with regard to the ownership of underground water, discussing cases, and among them the Jordeson Gasholder Case. 10500 w. Jour Gas Lgt—March 20, 1900. No. 33309 A.

Water Gas.

The Future of Water Gas in France. Just Alix. Part first consists of an introductory review of the gas industry, with some interesting figures relating to water gas, and the results obtainable with particular process and apparatus. 2000 w. Jour Gas Lgt—April 17, 1900. Serial. 1st part. No. 33849 A.

MARINE AND NAVAL ENGINEERING

Armor Plate.

See Mining and Metallurgy, Iron and Steel.

Balancing.

Graphic Method of Balancing Marine Engines. J. Macfarlane Gray. Description of method, with remarks. 1200 w. Engng—April 13, 1900. No. 33775 A.

Battleship.

The Imperial Japanese Battleship "Asahi." Illustrated detailed description, with comparison and comments. 1700 w. Engr, Lond—April 13, 1900. No. 33782 A.

The Japanese Battleship "Asahi." Illustration, with some general particulars and results of the speed trials. This is the largest battleship afloat. 1200 w. Engng—April 6, 1900. No. 33699 A.

Boilers.

Naval Boilers. Editorial discussion of the defects of the water-tube boiler, but advocating it for marine use. 1800 w. Engr, Lond—March 9, 1900. No. 33388 A.

British Engineers.

Naval Engineers. Editorial discussion of paper by D. B. Morrison. 3500 w. Engng—April 6, 1900. No. 33701 A.

The British Naval Engineer: His Present Position and Influence on Our Sea Power. D. B. Morison. Discusses the education and training; duties and responsibilities; present position, pay, etc. 16000 w. Brit Inst of Marine Engs & Naval Archs, Adv Proof—March 30, 1900. Also Engng—April 6, 1900. Serial. 1st part. No. 33477 E.

British Navy.

Admiralty Engineering. Considers in detail some of the aspects of engineering practice of the British Admiralty. 3600 w. Engr, Lond—March 30, 1900. Serial. 1st part. No. 33618 A.

Coaling Vessels.

The Miller Cableway for Coaling Vessels at Sea. Illustrated description of the device and its operation, with remarks. 2000 w. Eng News—April 5, 1900. No. 33450.

Commerce Destroyers.

The Commerce Destroyers (Les Croiseurs Corsaires). A short description of the new French 23-knot, 8,000-ton cruisers, with a discussion of their advantages and disadvantages. 1000 w. Le Yacht—March 17, 1900. No. 33851 C.

Comparison.

American Freight Locomotives and the Engines of the "Oceanic."—A Comparison of Horse Power. An interesting comparison of marine engines and locomotive horse power, with illustrations. 1800 w. Sci Am—March 31, 1900. No. 33365.

Cruiser.

U. S. Steel-Sheathed Protected Cruiser "Albany," Built at Elswick. Illustrated description. 500 w. Marine Engng—April, 1900. No. 33478 C.

Defense.

Warships and Seacoast Batteries. Operations of the American Squadron at Santiago de Cuba. Translated from the *Revue d'Artillerie* for April, 1899. Discussion. 4300 w. Jour U. S. Art—March-April, 1900. No. 33627 D.

Deutschland.

The Hamburg-American Atlantic Liner "Deutschland." Brief illustrated description. 800 w. Engng—March 23, 1900. No. 33389 A.

Ferryboats.

Coal Economy of Screw Ferryboats. E. A. Stevens. Treats of the type with one screw at each end, and takes four boats as examples, giving the conclusions reached. 1200 w. Stevens Ind—April, 1900. No. 33834 D.

Pennsylvania R. R. Ferryboats at New York. Illustrated detailed description of these fine boats. 600 w. Ry & Engng Rev —April 7, 1900. No. 33498.

Ferry Steamer with an Elevating Deck. Illustrated description of a vessel for servvice in Glasgow harbor, with an elevating deck, so that the deck may be brought to the same level as the quay at all stages of the tide. 1000 w. Sci Am—April 7, 1900. No. 33409.

Fouling.

The Fouling of Ships. W. H. Atherton. Read before the Northeast Coast Inst. of Engs. & Shipbuilders. Deals with the nature of fouling, the effect, and prevention. 3900 w. Engs' Gaz—April, 1900. No. 33605 A.

French Navy.

Launching of the "Montcalm," the "Dupleix," and the "Yatagan" (Lancement du "Montcalm," der "Dupleix," et du "Yatagan"). A short description of two armored cruisers and a torpedo boat destroyer, recently launched in France. 600 w. Le Yacht—March 31, 1900. No. 33852 C.

The Naval Policy of France (Après Fachoda: La Politique Navale de la France). Lieut. Emile Duboc. A criticism of the French naval programme, with a strong plea for a commerce-destroying policy in case of war with England. 5000 w. Questions Diplomatique et Coloniales—March 15, 1900. No. 33-854 C.

Japanese Battleship.

The Japanese Battleship "Shikishima" (Le Cuirassé Japanis Le "Shikishima"). A short account of this fine man-of-war, with two illustrations. 600 w. Le Yacht —March 31, 1900. No. 33853 C.

Jananese Navy.

The Imperial Japanese Navy. C. C. P. FitzGerald. Read before the Inst. of Nav. Archts. Reviews the history of this navy, its rise and development. 2800 w. Engng —April 6, 1900. No. 33702 A.

Light-Draught Steamers.

The Increasing Demand for Light-Draught Steamers. Waldon Fawcett. Reviewing the rapid extension in the use of boats of this type, the mechanical and marine problems solved in the construction, and presenting important examples built in many shipyards. Ill. 3000 w. The Engineering Magazine—May, 1900. No. 33901 B.

Liner.

The North German Lloyd Liner "Kaiserin Maria Theresia." Illustrated description of the reconstructed steamship, which has had 66 feet of the hull introduced amidships, and been thoroughly overhauled. 900 w. Sci Am—March 31, 1900. No. 33364.

The Launch of the Ocean Liner La Savoie (Le Lancement du Paquebot "la Savoie"). A brief illustrated description of this fine addition to the fleet of the *Compagnie Générale Transatlantique.* 600 w. Génie Civil—April 7, 1900. No. 33-594 D.

Narrow Channels.

Accidents to Vessels in Narrow Channels and the Proposed Great Lakes and Atlantic Ship Canal. Relates three recent accidents illustrating the defects and delays in the passage through narrow channels. 800 w. Eng News—April 19, 1900. No. 33729.

Naval Engineers.

French Naval Engineers. The position of the naval engineers in France is explained and the demands for increased numbers, better pay, and improved status. 1300 w. Engr, Lond—April 13, 1900. No. 33777 A.

Propellers.

Notes on Reversing Screw Propellers. The good qualities of propellers with reversible blades are presented and points discussed. 2400 w. Prac Engr—April 6, 1900. No. 33688 A.

Revenue Cutter.

Single Screw U. S. Revenue Cutter for the Great Lakes. Illustrated description of the vessel for the construction of which bids were recently opened at Washington. 1100 w. Marine Engng—April, 1900. No. 33481 C.

River Steamboat.

The First Class Passenger Steamboat "Kaiserin Auguste Victoria" (Der Salondampfer "Kaiserin Auguste Victoria"). A fully illustrated description of the boat and her engines. She runs on the Rhine. 2500 w. 2 plates. Zeitschr d Ver Deutscher Ing—March 24, 1900. No. 33555 D.

Rolling of Ships.

The Rolling of Ships on Waves. G. Russo. Read before the Inst. of Nav. Archts. The author's experimental method is described and results given. The apparatus used is illustrated and the principles explained. 3500 w. Engng—April 6, 1900. Serial. 1st part. No. 33700 A.

Russian Cruiser.

The First Class Russian Cruiser "Askold" (Der Russische Kreuzer I. Klasse "Askold"). A short illustrated description of this new 6000 ton cruiser, built at the *Germania* yard. 500 w. Stahl und Eisen—April 1, 1900. No. 33546 D.

School Ship.

The Engines of the Corvette "General Baquedano." Magnus Sandison. Illustrated description of the propelling engines, which possess some novel features. The vessel being a training ship, it was desirable that it be able to steam economically at low speeds. 1800 w. Engr, Lond—April 13, 1900. No. 33779 A.

Shipbuilding.

Shipbuilding in Navy Yards. Francis T. Bowles. Discusses the advantages and disadvantages. 2800 w. Naut Gaz—April 12, 1900. No. 33678.

Shipping and Shipbuilding in the United States. James W. Ross. Historical review of the rise and fall of this industry, and the present outlook. 4000 w. Sci Am Sup—April 28, 1900. No. 33831.

The Future of Ship Building. Charles H. Cramp. From *Harper's Weekly*. A review of the past history of this industry in America, and facts concerning Germany and Great Britain. 2000 w. Marine Rev—April 26, 1900. No. 33896.

The Practical Results of Some Innovations in Modern Shipbuilding. Henry B. Wortley. Read before the Inst. of Nav. Archts. Gives results of recent departures from ordinary practice, such as a rudder hung so that no stern frame has been required; the substitution of two pillars in the main hold in the place of numerous stanchions; a 3-ft. frame spacing; and the disuse of cement on the ship's bottom inside the ballast tanks. 4700 w. Engng—April 13, 1900. No. 33772 A.

Shipping.

International Competition in Shipping. Editorial on the expansion of British shipping, and the advance by other nations. 500 w. Engng—March 23, 1900. No. 33391 A.

The New Era in Lake Shipping. Waldon Fawcett. Illustrates and describes the latest type of ore vessels, with its carrying capacity of 8000 or 9000 tons, and reviews interesting developments. 2000 w. Eng & Min Jour—April 21, 1900. No. 33751.

Steamboat.

Magnificent Passenger Steamboat. Description of the "Tashmoo," a fine boat on the Great Lakes. 1100 w. Naut Gaz—April 5, 1900. No. 33447.

For Lake Michigan Service. Illustration and description of new Goodrich Line passenger steamer, with remarks on the attention given to life-saving appliances. 2000 w. Marine Rev—April 12, 1900. No. 33673.

New Steel Southern Steamer. Illustrated description of the "H. B. Plant," built by the Merrill-Stevens Engng. Co. 2200 w. Naut Gaz—April 26, 1900. No. 33847.

Steamship Service.

Wanted: Direct Steamship Service with Syria and Egypt. Explains the need of direct merchant steamers at regular intervals, in the interest of trade. 1000 w. U. S. Cons Repts, No. 709—April 20, 1900. No. 33732 D.

Steering.

Is the Steering of the Modern Screw-Propelled Vessel Defective? Cornelius W. McKay. Discusses the control of twin-screw ships. 3500 w. Sci Am Sup—March 31 and April 7, 1900. Serial. 2 parts. No. 33372.

Trans-Siberian Route.

The Marine Department of the Trans-

Siberian Railroad. Waldon Fawcett. Information concerning the boats which will serve as connecting lines in the breaks of rail line, with illustrations. 1400 w. Sci Am—March 31, 1900. No. 33366.

Trial Analysis.

Analysis of the Speed-Trial of the Twin-Screw Steam Yacht "Sovereign" by D. W. Taylor's Method of Trial Analysis. Robert S. Haight. Graduation thesis. Compares results by Taylor's method with those obtained by following Rankine's theory of the screw propeller. 1800 w. Stevens Ind—April, 1900. No. 33835 D.

Turrets.

The Superposed Turrets of the "Kearsarge." Illustrated description, with amount of test made to determine whether the structure could sustain the heavy strain while firing the guns. 1700 w. Sci Am—April 14, 1900. No. 33681.

Warship Equipment.

The Electrical Equipment of Ships of War. C. E. Grove. A record of what has already been accomplished, and the developments where it is likely to be applied. The practice of the British Admiralty is taken as a basis of the discussion. Ill. 19000 w. Brit Inst of Elec Engs, Adv Proof—April 5, 1900. No. 33476 E.

Wrecking.

The Use of Acetylene in Raising Sunken Vessels. Suggests the use of this gas, and gives illustrated description of apparatus to be used. 500 w. Sci Am—April 28, 1900. No. 33827.

Yacht.

Gasoline Yacht "Lady Francis." Drawings, photographs and description of a handsome vessel of this type recently completed. 700 w. Marine Engng—April, 1900. No. 33480 C.

Typical Forms of Racing Yachts. J. R. Barnett. Read before the Inst. of Engs. and Shipbuilders. Illustrations, with comparison of types and general remarks. 2300 w. Engs Gaz—April, 1900. No. 33604 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Competitive Tests of Accumulators by the Automobile Club of France (Concours d'Accumulateurs de l'Automobile Club de France). A. Bainville. An account of the tests made, with criticisms. 1400 w. L'Electricien—April 7, 1900. No. 33588 B.

Autocars.

The Autocar of To-day in Europe and America. Henry Sturmey. Read before the Automobile Club of Great Britain and Ireland. Reviews the advances made, the types used, the progress in different countries, etc. 3000 w. Automotor Jour—April, 1900. No. 33796 A.

Cab.

The Vedovelli and Priestley Cab. From *L'Industrie Electrique.* Illustrates and describes a vehicle interesting both in the method of steering and form of the body. 700 w. Sci Am Sup—April 14, 1900. No. 33684.

Comparisons.

A Lecture on Automobiles. Hiram Percy Maxim. Abstract of an address at the Knickerbocker Athletic Club of N. Y. Interesting comparisons of electric, gasoline and steam vehicles. 1300 w. Elec Rev. N. Y.—March 28, 1900. No. 33314.

De Dion Motor.

The De Dion Motor and Its Antecedents. Outline history of the light and heavy oil-engine, considering the De Dion and Bouton patents. 2800 w. Automotor Jour—April, 1900. No. 33792 A.

Delivery Wagons.

Power Consumption and Operative Costs of Automobile Delivery Wagons. George F. Sever. A study of the comparative costs of operation and maintenance of horse and electric delivery wagons for city service. 1300 w. Elec Rev, N. Y.—March 28, 1900. No. 33312.

Europe.

Automobilism in Europe. C. L. Durand. The principal automobile events in Europe during the Paris Exposition. 1500 w. Elec Rev, N. Y.—March 28, 1900. No. 33313.

Gasoline.

A Gasoline Carriage for Physicians. Illustrated description of the "Aesculapius," a recently exhibited vehicle. 400 w. Auto Mag—April, 1900. No. 33335 C.

Ignition.

Electric Ignition of Petrol Motors. E. C. Rimington. Considers briefly the principles of the induction coil, which is used to obtain the spark in the cylinder of the engine, the construction and the causes of failure to insure ignition. 2700

w. Automotor Jour—April, 1900. No. 33793 A.

Light Carriages.

The Light Road Carriage. Edward de Nôreme. Discusses the class termed by the Frenchmen a "voiturette," illustrating various types and describing the characteristic features. 2500 w. Auto Mag—April, 1900. No. 33333 C.

Oil Motor.

The Dawson Oil Motor. A general description explaining the principles, with a detailed account of its construction. Ill. 1700 w. Automotor Jour—April, 1900. No. 33791 A.

Oils as Sources of Energy in Explosion Engines. The advantages of the oil-engine are discussed, the merits of different oils as heating agents, the types of engine used, etc. 1800 w. Automotor Jour—April, 1900. No. 33795 A.

Omnibuses.

Automobile Omnibuses for Service in Cities. Describes types used in European cities, illustrating two of them. 500 w. Sci Am Sup—April 28, 1900. No. 33830.

Paris.

The Competition of the Automobile Club of France, (II. Concours des Voitures de Place Automobiles). G. Forestier. The full report of the commissioners, with many illustrations and tablets, on this competitive exhibition, held in June, 1899. Serial. Part I. 7000 w. Génie Civil—March 24, 1900. No. 33591 D.

Progress.

The Practical Automobile of the Future. E. E. Schwarzkopf. In praise of the fore-carriage and its economy. Ill. 1100 w. Auto Mag—April, 1900. No. 33334 C.

Races.

Two Automobile Road Races. An account of the races of March 31 and April 14, 1900, organized by the Automobile Club of America. 2500 w. Auto Mag—May, 1900. No. 33897 C.

Steam Car.

The Gardner-Serpollet Steam Car. Brief illustrated description. 600 w. Automotor Jour—April, 1900. No. 33794 A.

Trials.

Motor Carriage Trials. E. C. Oliver. Describes apparatus for testing automobiles, and the method of conducting such trials so that all conditions shall be kept constant, and results comparable. 2500 w. Horseless Age—April 18, 1900. No. 33743.

MACHINE WORKS AND FOUNDRIES.

Air-Hoist.

A Self-Propelling Air Hoist, with Unlimited Travel. Illustrated description of a novel apparatus and its operation. 900 w. Am Mach—April 26, 1900. No. 33814.

Bearings.

Roller and Ball Bearings. J. B. Detwiler. Read before the Mech. Supts.' Assn. Review of progress made in the use of these bearings, noting some of the interesting applications. 2000 w. Can Engr—April, 1900. No. 33680.

Belts.

Machine-Shop Belts. E. J. Armstrong. Suggestions concerning the care and attention needed to secure the maximum output. 1000 w. Am Mach—April 12, 1900. No. 33635.

Boring Machine.

The Universal Boring and Thread-cutting Machine of Paul Langbein (Universalbohr-und Gewindeschneid-maschine von Paul Langbein in Sarauno, Italien. D. R. P. 108990). A well illustrated account of a handy and serviceable tool which can be driven by belt or electric motor. 1300 w. Glaser's Ann f Gew u Bauw—March 15, 1900. No. 33523 D.

Castings.

Shot Iron and Hard Spots in Castings. Edward Kirk. Discusses the value of dump iron, showing it to be more economical to save only the larger pieces. Gives numerous experiments made in trying to utilize this material. 4000 w. Foundry—April, 1900. No. 33346.

Shrinkage of Malleable Iron Castings. H. O. Evans. Read before the Foundrymen's Assn., at Philadelphia. A reply to Dr. Moldenke's critique of Mr. Davis' paper. 1100 w. Ir Age—April 12, 1900. No. 33629.

Yellow Metal Castings. P. Longmuir. Suggestions for obtaining good results in this class of castings. Ill. 900 w. Foundry—April, 1900. No. 33349.

Cupolas.

A New Cupola Lining. Illustrated description of a lining formed of specially designed, hollow, cast-iron bricks. 1000 w. Engr, Lond—March 23, 1900. No. 33394 A.

Cutter.

A Pneumatic Boiler-Tube Cutter. Illustrates and describes a special tool operated by compressed air. 350 w. Am Mach—April 19, 1900. No. 33721.

Foundings.

Cast Iron in Foundings. Edward Kirk. How metalloids may be removed and how preserved while metal is in molten state. 1400 w. Am Mfr & Ir Wld—April 26, 1900. No. 33895.

Foundry Equipment.

Design and Equipment of Foundries.

R. P. Cunningham. Discusses the recent improvements in foundry construction and equipment. 2000 w. Foundry—April, 1900. No. 33347.

Gluing.

Purdue University Steaming and Gluing Apparatus. J. D. Hoffman. Illustrated description. 400 w. Am Mach—April 12, 1900. No. 33636.

Jigs.

A Novel Drill Jig. Joseph V. Woodworth. Illustrated description of the jig and its use. 400 w. Am Mach—April 12, 1900. No. 33634.

Joints.

Joints. Eli H. Pearce. Illustrated discussion of the care needed to make good joints in castings. 600 w. Foundry—April, 1900. No. 33348.

Molding.

Making Follow Boards. L. C. Jewett. Describes in detail the making of follow boards, and the materials used. 1100 w. Am Mach—April 26, 1900. No. 33813.

Molding a Large Planer Platen Without a Pattern. R. H. Palmer. Illustrates and describes the method used. 1400 w. Am Mach—April 19, 1900. No. 33722.

Power Consumption.

Power Consumption of Machine Tools (Kraftverbrauch von Arbeitsmaschinen). H. Loch. An article giving the power consumed by a great variety of machines, driven by electric motors, in the railway shops at Gleiwitz, Germany. 1200 w. Glaser's Ann f Gew u Bauw—April 1, 1900. No. 33525.

Rifle Barrels.

The Manufacture of Military Rifle Barrels. E. G. Parkhurst. Illustrated detailed description of the work as carried out by the Pratt & Whitney Co. 5000 w. Am Mach—April 26, 1900. No. 33812.

Shop Design.

New Saw-Tooth Roof Construction (Neue Sägedachanordnung). E. Förster. An illustrated description of the Nacke machine shops at Koswig, showing how the overhead shafting and cranes are arranged without interfering with the roof construction. 500 w. Zeitschr d Ver Deutscher Ing—March 17, 1900. No. 33552 D.

Shops.

New Shops of the Lodge & Shipley Machine Tool Company. Illustrates and describes five new shops in Cincinnati. 800 w. Am Mach—April 19, 1900. No. 33719.

The New Works of the Gisholt Machine Company. Illustrated detailed description of recently built works. 1000 w. Am Mach—April 12, 1900. No. 33632.

Sub-Presses.

Proportions of Sub-Presses. L. B. Charles. Illustrates and describes designs of this useful tool. 600 w. Am Mach—April 26, 1900. No. 33815.

Wheels.

Designing Spiral Wheels for Given Centers. Robert A. Bruce. Method is described and illustrated by an actual case. Diagrams. 2000 w. Am Mach—April 12, 1900. No. 33633.

Works Management.

Labor Questions in England and America. Charles Buxton Going. A review of the parallelism between the engineers' strike of 1897 and the machinists' strike of 1900, showing the futility of the union-labor efforts in America by their failure in Great Britain. 3600 w. The Engineering Magazine—May, 1900. No. 33898 B.

Manufacturers' Associations, Labor Organizations, and Arbitration. H. W. Hoyt. An example of practical co-operation between employers and trade unions is depicted, and the application of the same principles in other lines is strongly urged. 1800 w. The Engineering Magazine—May, 1900. No. 33899 B.

Works Management for the Maximum of Production. J. Slater Lewis. A discussion of union labor and the wage elements in affecting the cost of manufacturing, and of technical education as an aid in works management. Concluding an important series under this general title. 4500 w. The Engineering Magazine—May, 1900. No. 33900 B.

MATERIALS OF CONSTRUCTION.

Cast Iron.

The Chemistry and Physics of Cast Iron Briefly Considered. J. E. Johnson, Jr. Furnishes information from the large experience of the writer. 2500 w. Am Mach—April 5, 1900. Serial. 1st part. No. 33414.

Tests of the "Work Ability" and the Elasticity of Cast Iron of High Tensile Strength (Versuche über das Arbeitsvermögen un die Elastizität von Gusseisen mit Hoher Zugfestigkeit). C. Bach. Tests to determine the mechanical work per cubic centimeter performed by the pulling apart of the test pieces. 1400 w. Zeitschr d Ver Deutscher Ing—March 31, 1900. No. 33558 D.

Testing the Strength of Cast Iron. Walter J. May. Remarks on means of securing as accurate tests as possible. 1300 w. Col Guard—April 12, 1900. No. 33785 A.

Granular Structure.

The Alteration in the Internal Structure of Iron and Copper Through Changes of Form When Cold and Subsequent Annealing (Die Umwandlung des Kleingefüges bei Eisen und Kupfer durch Formänderung im Kalten Zustande und darauf folgendes Ausglühen). E. Heyn. A communication from the National Technical Laboratory, Charlottenburg, giving an elaborate and well illustrated account of the subject, treated microscopically. Serial. Part I. 4200 w. 2 plates. Beitschr d Ver Deutscher Ing—April 7, 1900. No. 33562 D.

POWER AND TRANSMISSION.

Car Dumpers.

Car Dumpers and Their Work. Waldon Fawcett. Illustrated descriptions of improved types of these machines, which transfer the contents of cars to the holds of vessels with a minimum of breakage. 1800 w. Am Mfr & Ir Wld—April 26, 1900. No. 33893.

Conveying Plant.

Electric Traveling Crane and Conveyor Plant. Illustrated description of the traveling electric crane at the Wandsworth supply station, and the other coal-handling mechanism. 1000 w. Engr, Lond—April 6, 1900. No. 33712 A.

Cranes.

A Novel Arrangement of Traveling Crane. The arrangement described has been adopted in works in Chicago. Ill. 400 w. Am Mach—April 19, 1900. No. 33723.

Governing.

Automatic Releasing and Governing Device for a Windmill Pump. Frederic W. Blanchard. Illustrates and describes an ingenious device capable of other applications. 1000 w. Am Mach—April 5, 1900. No. 33415.

Ore Unloader.

The Hulett Automatic Ore Unloader. Waldon Fawcett. Illustrated detailed description of the machine and its operation. 2500 w. Ir Age—April 5, 1900. No. 33400.

Lubrication.

The Effective Lubrication of Journals. F. W. Graham Snook. Shows by actual test that the most common method is extremely inefficient, and results in great preventible loss of mechanical efficiency, and suggests means of avoiding this loss. Ill. 4500 w. The Engineering Magazine—May, 1900. No. 33904 B.

Prony Brake.

An Improved Prony Brake. E. J. Armstrong. Illustrated description. 500 w. Am Mach—April 19, 1900. No. 33720.

Tile Kiln.

Steam Tile-Works at Cadinen (Dampfziegelei auf Cadinen). R. Weber. An illustrated description of the machinery for handling the material at the tile-kilns on the German Emperor's estate of Cadinen, West Prussia. 800 w. Zeitschr d Ver Deutscher Ing—March 17, 1900. No. 33553 D.

Water Power.

Greatest Water Power Development in the World. Illustrates and describes the operations at Sault Ste. Marie, and the mammoth water-power development. 5000 w. Marine Rev—April 5, 1900. No. 33484.

SPECIAL MOTORS.

Binary Engine.

The Binary-Vapor Engine. R. H. Thurston. Gives the recent experiments by Prof. Jorn, described by Mr. Frank Mason, commenting on the results, and giving additional information. Ill. 2000 w. Sib Jour of Engng—April, 1900. No. 33810 C.

"Crankless" Engine.

Ljungström's "Crankless" Engine. Illustrated description of this invention of a Swedish engineer. 1700 w. Col Guard—April 6, 1900. No. 33704 A.

Gas Engines.

A New Industrial Situation. Gives the views of Mr. George Westinghouse, and of Mr. R. H. Thurston in regard to the new gas engines and improvements for utilizing gas. Ill. 2500 w. Power—April, 1900. No. 33353.

Gas Engine Progress. C. V. Kerr. Read before the Nat. Assn. of Gas and Gasoline Engine Mfrs., at Chicago. Briefly traces the historical development from the beginning. 6300 w. Mod Mach—April, 1900. No. 33374.

Gas Engine Valves. Herbert L. Towle. Discusses valves opening directly into the cylinder or combustion spaces, considering the types that have been used or attempted. 1000 w. Horseless Age—April 4, 1900. Serial. 1st part. No. 33445.

Large Gas Engines in Modern Power Plants (Grosse Gasmotoren in Modernen Kraftbetrieben). Max Münzel. A paper before the Cologne branch of the *Verein deutscher Ingenieure*, giving a well illustrated description of some large gas engine power plants. 4200 w. Zeitschr d Ver Deutscher Ing—March 31, 1900. No. 33557 D.

Otto Gas Engines (Sur les Moteurs à Gaz à Explosion). L. Marchis. Theoretical discussion, with diagram, of the thermodynamics of the gas engines of the Otto type. 500 w. Comptes Rendus—March 12, 1900. No. 33583 D.

The Increasing Use of Large Gas Engines in Modern Power Plants (Ueber die Zunehmende Anwendung von Grossen Gasmotoren in Modernen Kraftbetrieben). H. Münzel. An address delivered before the Cologne branch of the *Verein deutscher Ingenieure*, giving a well illustrated account of the use of gas engines in many large plants. Two articles. 6000 w. 1 plate. Stahl und Eisen—March 15, April 1, 1900. No. 33543 each D.

The Utilization of Blast Furnace Gases for Generating Electric Power (Die Verwendung der Gichtgase zur Erzeugung Elektrischer Energie). A general account of the use of waste gas from blast furnaces in gas engines. 1600 w. Die Elektrizität—March 17, 1900. No. 33567 C.

Igniters.

Care of Electric Igniters. P. I. Panamolo. Illustrates the usual form of connection employed, and the points needing examination and attention are discussed, and directions given. 1300 w. W Elect'n —April 14, 1900. No. 33677.

Ignition.

Electrical Ignition for Gas and Gasoline Engines. P. P. Nungesser. An explanation of the most successful igniting devices in use at the present time, and the important details requiring attention. 2000 w. Elec Wld & Engr—April 7, 1900. No. 33493.

Thermal Efficiency.

The Efficiency of Steam and Gas Engines. Ed. C. de Segundo. Traces the development of the gas engine, and the limits of its economical use in the past, and refers to recent improvements which have greatly enlarged its usefulness. 2300 w. Jour Gas Lgt—April 3, 1900. No. 33609 A.

STEAM ENGINEERING.

Boilers.

Safety of Boiler Materials (Sicherheit der Kesselbaustoffe). Joh. Trnovskej. A compilation of the so-called "Hamburg" regulations and specifications for securing safety in boiler construction. 3000 w. Oesterr Monatschr f d Oeffent Baudienst —April, 1900. No. 33531 G.

The Boiler Plant on the Champ de Mars (Installation des Chaudières dans les Deux Grandes Usines du Champ-de-Mars). Emile Cayla. A well illustrated general description of the great plant for furnishing steam to the mechanical and electrical sections of the Paris Exposition. 4500 w. 1 plate. Génie Civil—April 7, 1900. No. 33592 D.

Condensation.

Observations on an Improved Glass Revealer, for Studying Condensation in Steam Engine Cylinders and Rendering the Effects Visible. Bryan Donkin. General description with an account of results obtained. Ill. 2000 w. Inst of Mech Engs—Adv. paper. No. 33370 D.

Explosion.

Boiler Explosion in an Iron Works. Illustrated description of the damage done by a water-tube boiler explosion, the path taken by the upper drum, etc. 1200 w. Locomotive—Feb., 1900. No. 33472.

Feed Water.

Boiler Feed Water. J. M. Williams. Paper read before Hamilton Assn., No. 2. C. A. S. E. Discusses water, from the boiler, and in the boiler. 2000 w. Power —April, 1900 w. No. 33353.

Gauges.

Water Gauges. Editorial on the imperfections of the methods in use for determining the level in the boiler. 1800 w. Engr, Lond—March 23, 1900. No. 33398 A.

Indicator.

The Application of the Indicator to the Main and Auxiliary Engines of a Cable Steamer. David Arnot. Diagrams and results collected with as great accuracy as possible. 1600 w. Prac Engr—March 23, 1900. No. 33375 A.

Injectors.

Steam Consumption of Injectors. Strickland L. Kneass. A discussion whether an injector using little or much steam is most economical, inasmuch as the only heat loss that can occur must be the radiation. 1800 w. Loc Engng—May, 1900. No. 33890 C.

Light Engine.

150 H. P. Steam Engine Weighing 1300 Pounds (Machine à Vapeur de 150 Chevaux Effectifs Pèsant 600 Kilogrammes). A brief account of a very light engine built by Boultes and Larbodière, France. 200 w. Revue Technique—March 25, 1900. No. 33850 D.

Pipes.

Steam Pipes. H. de B. Parsons. Discusses the materials, brazing, duplicate system, allowance for expansion, general design, valves, and drips. 4500 w. Stevens Ind—April, 1900. No. 33836 D.

Smoke Consuming.

An Improvement in Smoke Consuming Furnaces. Illustrated description of an invention for supplying atmospheric oxygen to the fire only at the time when smoke is produced. 700 w. Sci Am—March 31, 1900. No. 33363.

Steam Plows.

Cultivation with Steam Plows. J. L. Thompson. Gives an account of experience in Australia and cost of preparing the ground as compared with horses. 1700 w. Am Mfr & Ir Wld—April 12, 1900. No. 33679.

Tension.

The Tension in Cylinder-Head Studs. W. F. Durand. Considers the relation of the initial tension on the stud-bolt due to setting up the nut, to the final resultant stress when the bolts are carrying the steam load. 1100 w. Sib Jour of Engng —April, 1900. No. 33811 C.

Turbines.

The Westinghouse-Parsons Steam Turbines Operating Westinghouse Air-Brake Works. Illustrated detailed description of this plant, where these machines furnish the motive power and lighting. 2800 w. Ir Age—April 12, 1900. No. 33628.

Valves.

Poppet Valves: Their Construction and Calculation. L. Berger. Gives illustrated description of the construction of the valves, and considers the calculations for the springs with the object of obtaining the best performance possible. 1600 w. Horseless Age—April 18, 1900. No. 33-742.

MISCELLANY.

Approximate Formulæ.

Approximate Formulæ and their Application in Technical Calculations (Ueber Näherungsgleichungen und deren Anwendung bei Technischen Rechnungen). Dr. J. B. Goebel. Some approximate equations with their applications to hydraulics and safety vales. 800 w. Gesundheits Ing—March 31, 1900. No. 33520 B.

Compressed Air.

The Hydraulic System of Air Compression. Illustrated description of a system in successful operation for two years at Magog, Quebec. 2000 w. Sci Am—April 28, 1900. No. 33828.

An Occurrence of Hydrocarbons in Compressed Air (Ueber ein Vorkommen von Kohlenwasser-stoffen in Druckluft). H. Kette. An account of the formation of explosive gases owing to the volatilization of lubricating oils in an air compressor, near Dortmund, Westphalia. 1500 w. Glückauf—March 17, 1900. No. 33569 B.

Ice Machines.

To Prove Efficiency of Ice Machines Without a Trial Test. J. C. Bertsch. Explains the way to find the work of the machine on the card drawn by the indicator; and tests of ammonia compression machines do not prove efficiency. 3900 w. Ice & Refrig—April, 1900. No. 33352 C.

Invention.

Machinery—Labor-Saving, Labor-Creating or Labor-Killing? Alberta A. Field. An argument against ideas advanced in a work by J. Howard Moore, of Chicago, entitled "Better World Philosophy." 2500 w. Sci Am Sup—April 14, 1900. No. 33682.

Liquid Air.

The Practical Applications of Liquid Air. Carl Linde. Read before the Soc. of German Naturalists and Physicians at Munich. Translated from the *Zeitschr. d Ver Deutscher Ing.* Discusses the possible uses, indicating the limitations. 3000 w. Eng News—April 5, 1900. No. 33454.

Commercial Value of Liquid Air. Alfred Siebert. Gives reasons for its inapplicability for refrigeration and power, considers its cost and refrigerating capacity, etc. 2500 w. Ice & Refrig—May, 1900. No. 33982 C.

Measurements.

Evolution of Standard Measurements. John A. Brashear. On the methods employed in all ages, the legislation, and the birth of the metric and foot rule. 5500 w. Am Mfr & Ir Wld—March 29, 1900. No. 33311.

Ordnance.

Krupp Central Pivot Gravity and Spring-Return Carriages for Naval Ordnance. Illustrates and describes these two ways of mounting guns. 1000 w. Sci Am Sup—March 31, 1900. No. 33371.

Planimeter.

A Simple Explanation of the Construction and Uses of the Planimeter. Cecil H. Peabody. A brief illustrated description of various forms of this instrument, with a simple but complete discussion of its principle. 1500 w. Marine Engng—April, 1900. Serial. 1st part. No. 33-479 C.

Refrigeration.

Cold Storage in Toledo. Illustrated description of the Toledo Cold Storage Co.'s ice-making plant, its construction, equipment and capacity. 2000 w. Ice & Refrig—May, 1900. No. 33981 C.

Siege Trains.

A Sketch of the Siege Artillery Train at Camp Rodgers, Tampa, Florida, During the Summer of 1898. E. W. Hubbard. An account of the development of a powerful collection of artillery, with an outline of some of the difficulties met and conquered. 1600 w. Jour U. S. Art—March-April, 1900. No. 33625 D.

Steel Pens.

The Manufacture of Steel Pens (Die Stahlfederfabrikation). P. T. Richter. An address delivered before the *Verein für Eisenbahnkunde*, Berlin, giving a full and well illustrated account of the manufacture of steel pens as carried on at the works of Messrs. Heintze and Blanckertz. 8000 w. Glaser's Ann f Gew u Bauw—April 1, 1900. No. 33524 D.

Temperatures.

The Determination of High Temperatures. A. A. Watson. Describes some of the methods of accurately estimating high temperatures, and the scientific principles involved. 2000 w. B C Min Rec—April, 1900. No. 33602 C.

MINING AND METALLURGY

COAL AND COKE.

British Coal.

British Coal Resources. A. D. Provand. Letter to the First Lord of the Treasury calling attention to new facts ascertained since the Royal Commission reported in 1871. 1200 w. Col Guard—March 23, 1900. No. 33385 A.

Checks.

Checks for Sharp Curves on Engine Planes. Idris Thomas, in the *Journal of the British Soc. of Min. Students.* Illustrates and describes a check used at the Caerau Colliery, Maesteg. 350 w. Col Guard—April 6, 1900. No. 33705 A.

Coal Measures.

Identification of an Ohio Coal Measures Horizon in New Mexico. C. L. Herrick and T. A. Bendrat. Calls attention to the remarkable similarity of forms in the measures near Newark, Ohio, and Albuquerque, N. M. 2500 w. Am Geol—April, 1900. No. 33474 D.

Culm Flushing.

Flushing of Culm in Anthracite Coal Mines. William Griffith. Brief general description of the process with illustrations; also discussion of the advantages and of the saving effected. 3000 w. Jour Fr Inst—April, 1900. No. 33342 D.

Gob-Fires.

Gob-Fires. A Review of Some Recent Theories. H. W. Halbaum. Considers their causes and means to prevent or extinguish them. Discusses whether Mr. Stoker's theories are really new and sound. 3000 w. Col Guard—March 23, 1900. No. 33386 A.

Missouri.

Mine No. 15, Rich Hill, Missouri. Charles Evans. A description of its equipment, including a new electric haulage plant, by which the output has been increased. 1000 w. Mines & Min—April, 1900. No. 33433 C.

Outcrops.

Dangerous Outcrops under Quicksand Deposits. G. M. Williams. Illustrates and describes a formation found in the ancient river bed of the Wyoming coal basin, which has caused great trouble and expense in mining. 3800 w. Mines & Min—April, 1900. No. 33432 C.

Rontgen Tests.

Testing Coal by Means of Röntgen Rays (Untersuchung von Kohlen mittels Röntgenstrahlen). F. Kotte. Short account, with good illustrations, of Röntgen ray tests of powdered coal. 400 w. Stahl und Eisen—April 4, 1900. No. 33545 D.

Russia.

The Coal Crisis in Russia and the Main Sources of Native Supply. H. Cooke. A Foreign Office report. Discusses the present scarcity and high price of coal, and the causes, and remedies. 2500 w. Col Guard—March 23, 1900. No. 33387 A.

Strikes.

Coal Strikes and Miners' Wages in Austria. An account of a determined contest between capital and labor, now going on in the northern provinces. 800 w. U. S. Cons Repts, No. 704—April 14, 1900. No. 33651 D.

Surface Arrangements.

Colliery Surface Arrangements. Ernest H. Thomas. A Lewis prize essay, 1899, printed in the Pro. of the So. Wales Inst. of Engs. Illustrated description of some of the recent improvements for the delivery of coal from the pit cage to the railway wagon. 5500 w. Col Guard—March 30, 1900. No. 33620 A.

Colliery Surface Arrangements. S. A. Everett. A Lewis prize essay. Printed in Pro. of the So. Wales Inst. of Engs. (First Prize.) Describes typical conditions and the method of handling coal with as little breakage as possible, sorting and cleaning with minimum labor. Ill. 7000 w. Col Guard—April 6, 1900. No. 33706 A.

Washing.

New Coal-Washing Plant at the Cadeby Colliery. Illustrated detailed description. 1800 w. Ir & Coal Trades Rev —March 23, 1900. No. 33382 A.

Rapid Coal Tests and Check on Coal Washing. M. Maurice. Describes the method used by the writer, his manner of operating, and of determining the water constant, composition of the shale and coal, and perhaps the ash content. 3800 w. Col Guard—April 6, 1900. No. 33707 A.

Weighing.

Automatic Coal-Weighing and Recording Machines. Charles Ingrey. Abstract of paper read at meeting of the Cleveland Inst. of Engs. The writer's views of what should constitute a perfect automatic coal-weighing and recording machine, describing one designed by himself, which he claimed fulfilled these conditions. 3000 w. Col Guard—April 6, 1900. No. 33703 A.

COPPER.

Butte.

The Mines of Butte. Arthur Lakes.

An illustrated description of the great concentrating and smelting plants, enormous hoisting machinery, the extensive ore body, and various devices by which the great copper output is obtained. 3000 w. Mines & Min—April, 1900. No. 33428 C.

Mexico.

Copper Mining at Placeritas de Nacosari, Sonora, Mexico. H. B. Layton. Illustrated detailed account of the mines and works of the Montezuma Copper Co. 4000 w. Min & Sci Pr—March 31, 1900. No. 33406.

New Jersey.

Schuyler Copper Mines. An abandoned copper property which is to be reopened and developed by modern methods. 800 w. Mines & Min—April, 1900. No. 33437 C.

Ore.

Something About Copper Ore. Albert R. Ledoux. Extract from a lecture delivered before the N. Y. Elec. Soc. An account of the deposits and the steps through which the ore passes. 1200 w. Am Mfr & Ir Wld—April 26, 1900. No. 33894.

Panuco.

The Panuco Copper Mine Deal. An account of a mine in Mexico, floated by a London company, which has proved of little value. 1200 w. Eng & Min Jour—April 21, 1900. No. 33748.

Refining.

Copper from the Ore to the Wire Bar. Albert R. Ledoux. Synopsis of a lecture before the N. Y. Elec Soc. Describes the deposits, the furnaces and various steps in detail. 3200 w. Elec Rev, N. Y.—April 11, 1900. No. 33631.

Supply.

The World's Copper Supply. H. J. Stevens. A review of the copper industry. 1500 w. Mines & Min—April, 1900. No. 33431 C.

Yukon.

Yukon Territory—Lewis River Copper District. W. M. Brewer. Brief description of this district. 500 w. Eng & Min Jour—March 31, 1900. No. 33358.

GOLD AND SILVER.

Amalgamation.

Amalgamation of Metals, Normal and Electrolytic. J. H. Jory. Presents facts concerning amalgamation and the value of electrolytic amalgamation. 2000 w. Min & Sci Pr—April 21, 1900. No. 33816.

Assaying.

Losses in the Determination of Gold and Silver in Copper Bullion, Their Causes, and a Method for Overcoming Them. W. Randolph Van Liew. 2000 w. Eng & Min Jour—April 21, 1900. Serial. 1st part. No. 33752.

Bokhara.

The Gold-Bearing Conglomerates of Bokhara. Information from a lecture delivered before the Royal Geog. Soc. in London, by W. Rickmers. 800 w. Eng & Min Jour—April 21, 1900. No. 33750.

British Columbia.

Vancouver Island—Alberni District William M. Brewer. An illustrated description of this property, which is the most thoroughly developed on the island, having been opened to a depth of 350 ft. 1900 w. Eng & Min Jour—April 21, 1900. No. 33749.

West Kootenay Mining District—Rossland. William M. Brewer. A report of recent work in this district, changes in management, etc. 1000 w. Eng & Min Jour—April 7, 1900. No. 33439.

Colorado.

Mineral Resources of Colorado. G. Frank Judson. Part first begins a review of the Cripple Creek district. Ill. 2500 w. Min Rept—April 12, 1900. Serial. 1st part. No. 33696.

The Lamartine Mine at Idaho Springs, Colorado. Arthur Lakes. An illustrated account of a celebrated gold and silver mine with a difficult drainage problem. 3000 w. Mines & Min—April, 1900. No. 33427 C.

Concentrator.

The New Peck-Montana Concentrator. George W. Winter. Illustrated description of the Peck concentrator at the Peck-Montana mill. 1300 w. Eng & Min Jour—March 31, 1900. No. 33357.

Cyanide.

Some Observations on Practice of the Cyanide Process at Mercur, Utah. William Magenau. A classification of the ores based on the mode of treatment is given, with outline and notes concerning the treatment of the oxidized ore. 2500 w. Min & Sci Pr—April 21, 1900. Serial. 1st part. No. 33818.

Dredging.

Gold Dredging in New Zealand. Illustrated description of one of the largest dredges used, and its operation, with information concerning cost and working. 1800 w. Engng—April 13, 1900. No. 33776 A.

Gold Dredging in Borneo. An interesting interview with T. R. Toby, who has been recently on an exploring and prospecting trip in West Borneo. Considers the country sure to become a great gold producer. Ill. 2400 w. Aust Min Stand—March 15, 1900. No. 33832 B.

Gold-Dredging in New Zealand. Victoria and New South Wales. George

Robson. Information concerning the process, with general discussion. 2800 w. N Z Mines Rec—Jan. 16, 1900. No. 33488 B.

Lixiviation.

The Lixiviation of Gold Deposits by Vegetation. Emil E. Lungwitz. Discusses this subject, giving report of personal experiments. 3000 w. Eng & Min Jour—April 28, 1900. No. 33786.

Mexico.

The Batopilas Mines, Mexico. Abstract of the general manager's report showing the present condition and prospects. Also editorial. 3800 w. Eng & Min Jour—April 14, 1900. No. 33668.

New Zealand.

New Zealand's First Mining Speculation. Ro. Carrick. Narrates incidents in the discovery and early development of mining in New Zealand. 1400 w. N Z Mines Rec—Jan. 16, 1900. No. 33489 B.

Pacific Coast.

Beach Sands of the Pacific Coast. W. J. Adams. Discusses their origin, methods of working, devices used, etc. Ill. 4500 w. Mod Mach—April, 1900. No. 33373.

Placers.

Southern Oregon Placer Conditions. Theo. F. Van Wagenen. Interesting information relating to this region. 1300 w. Min & Sci Pr—April 21, 1900. No. 33817.

The Placer Fields of Custer County, Idaho. C. C. Clawson. History of the work in this locality, and the recent revival of mining. 1700 w. Eng & Min Jour—April 14, 1900. No. 33669.

Prospecting.

Cost of Prospecting by Drilling in Joplin District. Harold A. Titcomb. Describes the method employed, giving report of cost, which is largely dependent on the speed. 1000 w. Eng & Min Jour—April 7, 1900. No. 33438.

Prospectors' Mistakes. The first of a series of articles on this subject. 1000 w. Min & Sci Pr—March 31, 1900. Serial. 1st part. No. 33407.

Sluicing.

Hydraulic Sluicing in the Collingwood District. H. F. Logan. Descriptive. 2400 w. N Z Mines Rec—Feb. 16, 1900. No. 33490 B.

Transvaal.

Transvaal Gold Mines (Mines d'Or du Transvaal). Extracts from the reports of the engineers in charge of some of the mines which are being temporarily worked by the Transvaal government, up to the end of 1899. 1500 w. Moniteur Industriel—March 17, 1900. No. 33595 E.

IRON AND STEEL.

American Works.

Novelties in American Steel Works (Neuerungen bei Amerikanischen Stahlwerken). H. Staunnschulte. An address delivered before the *Eisenhütte Oberschlesien,* giving an illustrated description of new improvements in various American steel plants. 2200 w. Stahl und Eisen—April 1, 1900. No. 33544 D.

Armor Plate.

Armor Plate Manufacture in Germany. Brief consideration of the effect upon this industry of the scheme for increasing the German navy. 1200 w. Engr, Lond—April 13, 1900. No. 33781 A.

Armor Plates. A review of progress in the manufacture in the different countries. 2500 w. Engng—April 6, 1900. No. 33698 A.

Some Notes on the Development of Armor for Naval Purposes. Discusses the various forms and qualities of armor, and the cost at which it has been supplied at different periods. 4700 w. Ir & Coal Trds Rev—April 13, 1900. No. 33800 A.

Blast Furnaces.

Utilizing the Heat of Molten Slag. Herbert Lang. A letter discussing Mr. Bretherton's invention and the subject in general. 2800 w. Eng & Min Jour—April 28, 1900. No. 33838.

Crucible Steel.

Crucible Steel (Tiegelstahl). O. Thallner. A paper read before the Upper Silesian branch of the *Verein Deutscher Ingenieure,* giving an account, with table and curves, of crucible steel and its manufacture at the Bismarck works, in Silesia. 2200 w. Zeitschr d Ver Deutscher Ing—March 31, 1900. No. 33561 D.

Furnace.

Ingot Heating Furnace. Specification, with illustrations of a new heating furnace, designed to heat cast-steel ingots. 1200 w. Am Mfr & Ir Wld—April 5, 1900. No. 33483.

Tipping Furnace for Combined Martin and Bessemer Process. P. Eyermann, in *Stahl und Eisen.* Describes a new method of regenerating crude iron, giving illustration of the furnace. 2000 w. Col Guard—March 30, 1900. No. 33619 A.

Japan.

The Manufacture of Iron in the East. B. H. Thwaite. Detailed description of the new Japanese Government Iron and Steel Works. 2000 w. Ind & East Engr—March, 1900. No. 33652 D.

Labrador.

The Iron Ores of the Labrador Peninsula. A. P. Low. An interesting illustrated account of a personal examination of some yet unworked deposits, describing the occurrence, character, and analysis of the ores and the general facilities of the region. Ill. 2200 w. The Engineering Magazine—May, 1900. No. 33903 B.

Lake Superior.

The Lake Superior District in 1900. Waldon Fawcett. Some of the conditions tending to increase the production of iron ore. Preparations for haulage, storage and loading. Ill. 1500 w. Am Mfr & Ir Wld—April 5, 1900. No. 33482.

Martin Furnaces.

Tipping Martin Furnaces (Zur Frage der Kippbaren Martinöfen). P. Eyermann. An illustrated account of improvements in the details of the Martin basic steel process. 2000 w. Stahl und Eisen—March 15, 1900. No. 33542 D.

Newfoundland.

The Wabana Iron-Ore Mines. H. B. C. Nitze. Illustrates and describes rich deposits on the island of Newfoundland which are mined by open quarries close to deep-water shipping facilities. 1000 w. Mines & Min—April, 1900. No. 33-434 C.

Norway.

Iron Ore Deposits of Dunderland, Norway. H. L. Geissel. Brief account of rich deposits of great extent. 700 w. Eng News—April 26, 1900. No. 33825.

Otto's Process.

A New Direct Process. Briefly reviews various methods that have been tried, and describes the process patented by Carl Otto for the direct production of iron and steel, with critical comment. Ill. 2800 w. Ir & Coal Trds Rev—April 13, 1900. No. 33801 A.

Steel Makers.

The Great Steel Makers of Pittsburg and the Frick-Carnegie Suit. Julius Moritzen. An explanation of the suit, with review of Mr. Carnegie's career, and also of the life of H. C. Frick, giving a brief account of the company. Ill. 6500 w. Rev of Revs—April, 1900. No. 33-350 C.

West Africa.

The Native Iron Industry in German West Africa. F. Hupfeld, in *Stahl und Eisen*. Describes the manner of working, the location of deposits, etc. 1300 w. Col Guard—March 30, 1900. No. 33-622 A.

MINING.

Accidents.

Compilation of the Fatal and Disabling Accidents in the Breslau Mining District, Germany (Zusammenstellung der im Jahre, 1899, im Oberbergamtsbezirke Breslau beim Bergwerksbetriebe Vorgekommenen Tödtlichen Verunglückungen). A list of the accidents to miners which were fatal, and those which disabled for four weeks or more. 200 w. Glückauf—April 7, 1900. No. 33574 B.

Belgium.

Mining and Metallurgy in Belgium During 1898 and the First Half of 1899 (Bergwerks und Hüttenbetrieb in Belgien im Jahre, 1898, und im I. Semester 1899). A short article taken from the *Annales des Mines de Belgique,* giving tables showing the production of mines, accidents, etc. 400 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 17, 1900. No. 33535 B.

Camps.

Mining Camps of the Northwest. Arthur Lakes. A sketch of some of the leading camps in Northern Washington, Idaho, Oregon, and British Columbia. 2800 w. Mines & Min—April, 1900. No. 33436 C.

Electric Machinery.

See Electrical Engineering, Power Application.

Errors.

Mining Errors. F. Danvers Power. Read before the New South Wales Chamber of Mines. Discusses prospectus writing, promoters, directors, mine management, and experts. 2500 w. Ir & Coal Trds Rev—March 30, 1900. No. 33624 A.

Explosives.

Modern Explosives. J. S. S. Brame. A lecture delivered at the London Inst. A discussion of such explosives as are most used in modern warfare. 4000 w. Nature—April 5, 1900. No. 33687 A.

The Question of Underground Magazines for Explosives (Zur Frage der Unterirdischen Sprengstoff Magazine). Franz Prispisil. A paper before the *Berg-und Hüttenmännischen Vereines* in Ostrawa, Moravia, with various tables. Two articles. 4500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 17, 24, 1900. No. 33534 each B.

The Theory of Safety Explosives (Zur Theorie der Sicherheitssprengstoffe). H. Heise. An abstract of an essay by the Austrian General Hess on substances which explode so rapidly that the surrounding atmosphere has not time to take up the shock and so is compressed and raised to a dangerous temperature. 1400 w. 1 plate. Glückauf—March 24, 1900. No. 33570 B.

Fans.

Fan Volume Recorder. M. Murgue. Illustrated description of apparatus for recording the volume of air delivered and the method of using it. 3200 w. Col Guard—April 12, 1900. No. 33783 A.

Fuses.

The Evolution of Safe and Accurate

Fuse Protective Devices. Joseph Sachs. An illustrated description of the enclosed fuse and discussion of the principles on which it is based and operates. General discussion. 15000 w. Trans Am Inst of Elec Engs—Feb., 1900. No. 33475 D.

Hand Drill.

Improved Heise Hand Drills (Verbesserungen der Heiseschen Handbohrmaschine). A short account, calling attention to improvements. 600 w. 1 plate. Glückauf—April 1, 1900. No. 33571 B.

Inclines.

The Safety Aspect of Inclines. Henri Ghysen. From a communication to the Charleroi Section of the Assn. des Ingenieurs de Liege. Considers the pulley with its brake, and the fence closing the incline, describing arrangements for safety. Ill. 2800 w. Col Guard—March 30, 1900. No. 33621 A.

Quarrying.

The Quarrying Industry in France. Arthur Lee. Interesting account of the quarries and their products, the amount of labor employed, etc. Ill. 3000 w. Stone—April, 1900. No. 33637 C.

Shafts.

A New Method of Shaft Sinking. G. C. McFarlane. Illustrates and describes a method of sinking when it is necessary to go through water bearing strata. 800 w. Eng & Min Jour—April 7, 1900. No. 33442.

Boring a Pair of Shafts Through Heavily-Watered Measures. M. L. Petit. From a communication to the Société des Ingénièurs des Mines du Hainaut. Illustrates and describes a difficult piece of mining work. The shafts were passed through heavily-watered measures and quicksands. 4800 w. Col Guard—March 23, 1900. No. 33384 A.

Shifts.

The Length of Shifts in the Ostrawa-Karwin Coal District (Ueber die Schichtdauer im Ostran-Karwiner Kohlenrevier). Max von Gutmann. Paper before the Austrian *Ingenieur-und Architekten-Vereines,* giving a full discussion of the subject of the hours of labor in coal mines, with many tables. Two articles. 6000 w. 2 plates. Oesterr Zeitschr f Berg u Hüttenwesen—March 24, 31, 1900. No. 33536 each B.

Surveys.

Surveys in Inclined Shafts. Joseph Barrell. Theoretical and practical considerations governing the choice of instruments. 2700 w. Mines & Min—April, 1900. No. 33435 C.

Underground Surveys and Their Connection with the Surface by the Transit Method. E. H. Liveing. Read before the Midland Inst. of Min., Civ., & Mech. Engs., at Leeds, Eng. Particulars from the writer's experience in the use of this method. Ill. 2500 w. Prac Engr—March 23, 1900. No. 33376 A.

Unwatering.

Balancing Boilers for Unwatering Mines. William Kelly. Illustration and description of method. 900 w. Eng & Min Jour—April 14, 1900. No. 33670.

Wages.

The Wages of Miners in Prussia in 1899 (Die Bergarbeiterlöhne im IV. Vierteljahre, sowie im Ganzen Jahre 1899). Tables published in the *Reichsauzeiger,* giving wages statistics for the various mining industries. 1000 w. Glückauf—March 17, 1900. No. 33575 B.

Winding.

Combined Safety Clutch and Stopping Device for Winding Cages. O. Schenck, in *Allgemeine bergmannische Zeitschrift.* Illustrated detailed description. 800 w. Col Guard—April 12, 1900. No. 33784 A.

Fowler's Hydraulic Decking Arrangement. Illustrates and describes the arrangement in use at Cinder Hill Colliery, Nottingham. It was invented to save the time taken up in changing the decks of the winding cages. 1600 w. Ir & Coal Trds Rev—March 23, 1900. No. 33383 A.

MISCELLANY.

Aluminum.

The Progress of Aluminum. A review of the position and prospects, and general information. 4500 w. Engr, Lond—March 23, 1900. No. 33393 A.

The Relations of Aluminum to Iron. Godfrey Melland. Abstract of a paper read before the So. Staffordshire Ir. and Steel Inst. Reviews facts ascertained, considering the alloys, and the use of aluminum in the treatment of malleable and cast iron. 2000 w. Ir & Coal Trds Rev—March 30, 1900. No. 33623 A.

Asbestos.

Asbestos. A. Selwyn Brown. Describes this peculiar mineral and gives interesting information concerning the locations of deposits, the production, uses, etc. 2000 w. Aust Min Stand—March 1, 1900. No. 33601 B.

The Asbestos Mines at Thetford, Canada. L. P. Gratacap. Illustrates and describes the deposits and their workings, with information concerning the value, uses, etc. 1100 w. Sci Am—April 7, 1900. No. 33408.

Assaying.

Nickel and Cobalt Assaying. M. E. D. Merry. Describes a speedy and accurate method in use for about fifty years, and never before published. 1500 w. B. C. Min Rec—April, 1900. No. 33603 C.

Diamonds.

A Big Diamond Deal. W. S. Dowel. An account of the De Beers purchase, and the cashing of a check for £5,338,650. 1200 w. Aust Min Stand—March 1, 1900. No. 33600 B.

Ecuador.

Minerals and Mining in Ecuador. Facts furnished by a French metallurgist who is regarded as an authority. 1700 w. U. S. Cons Repts, No. 694—April 3, 1900. No. 33368 D.

Fuller's Earth.

Fuller's Earth. J. Ohly. Describes the manner of formation, the uses to which it is applied, the deposits, etc. 2500 w. Min Rept—March 29, 1900. No. 33399.

Germany.

The Mining Products of Germany and Luxemburg for 1899 (Die Gewinnung der Bergwerke, Salinen und Hütten im Deutschen Reich und in Luxemburg während des Jahres, 1899). Preliminary official report, giving tables of both raw and manufactured mineral products, both as to weight and market value. 500 w. Glückauf—April 7, 1900. No. 33573 B.

Graphite.

The Occurrence, Treatment and Application of Graphite. W. F. Downs. Part first is introductory to a series of articles which will treat of the occurrence, gradation, preparation and application. 700 w. Ir Age—April 19, 1900. Serial. 1st part. No. 33714.

Hydrocarbons.

The Hydrocarbons of Eastern Utah. Don Maguire. With special reference to the deposits of ozokerite, gilsonite, and elaterite. Their properties, and the uses to which they are adapted. The forms of the deposits, their situation, and the extent to which they have been prospected and developed. 2800 w. Mines & Min—April, 1900. No. 33429 C.

Mexico.

The Avino Mine, Mexico. An illustrated description of a modern plant which takes the place of a primitive one at one of the oldest mines in Mexico. 1500 w. Mines & Min—April, 1900. No. 33430 C.

Museum.

The Egleston Mineralogical Museum of Columbia University. Alfred J. Moses. An account of this museum, its collections, classification, etc. 1600 w. Eng & Min Jour—April 7, 1900. No. 33440.

Nitric Acid.

Lyte and Lunge's Nitric Acid Process. Julius L. F. Vogel. Describes an improved process which leaves the soda portion in its most valuable form, and in which there is no waste product. Ill. 2200 w. Eng & Min Jour—April 7, 1900. No. 33441.

Petroleum.

The Russian Petroleum Trade. An account of the production, consumption, cost, extension of territory, etc., with statistics of trade. 5000 w. U. S. Cons Repts, No. 706—April 17, 1900. No. 33-685 D.

Scrip and the Law of Title to Oil Lands. A. H. Ricketts. An explanation of the term "scrip" and the names by which it is known are given in part first. 2500 w. Min & Sci Pr—April 7, 1900. Serial. 1st part. No. 33641.

Philippines.

Some of the Resources of the Philippines. G. D. Rice. An account of the minerals and methods of mining, native labor, etc. 1700 w. Eng & Min Jour—April 14, 1900. No. 33667.

Tin.

Greenbushes Tin-Field. Information concerning the situation and the character of these deposits, which are known to contain deleterious impurities, difficult to eliminate. 2200 w. Aust Min Stand—March 15, 1900. No. 33833 B.

Turquoise.

The Turquoise Mines of Persia. H. L. Geissel. An account of the only mines producing this stone, and of the primitive method of mining. 1100 w. Sci Am—April 21, 1900. No. 33715.

Zinc.

Zinc Deposits. C. C. Longridge. A tabular statement illustrating the geological distribution of zinc ores, with interesting information. 1000 w. Engr, Lond—April 6, 1900. No. 33711 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in February. Detailed list and classified summary. 3500 w. R R Gaz—April 6, 1900. No. 33463.

Train Accidents in the United States in March. Detailed list and classified summary, with comments. 3500 w. R R Gaz—April 27, 1900. No. 33842.

Boarding Moving Trains.

The Taking Up of Passengers and Baggage by Moving Trains (Die Uebernahme von Personen und Gepäck durch Fahrende Bahnzüge). An illustrated account of a system recently patented at Berlin, by which a motor car is to accompany moving trains for a short stretch at stations and transfer passengers and freight. 700 w. Oesterr Monatschr f d Oeffent Baudienst—April, 1900. No. 33533 G.

Double Heading.

Double Heading. C. B. Conger. Discussion of this practice, which has become common in these days of heavy trains. 1600 w. Loc Engng—May, 1900. No. 33887 C.

Fighting Snow.

Fighting Snow in Alaska. An illustrated account of the difficulties encountered in operating trains on the White Pass & Yukon Ry. 500 w. Ry & Engng Rev—April 7, 1900. No. 33497.

Pennsylvania R. R.

Organization of the Pennsylvania Railroad. Diagram, showing in graphic form the official relations of all the general officers and heads of departments. 400 w. R R Gaz—April 27, 1900. No. 33841.

FINANCIAL.

Air Line.

The Greater Seaboard Air Line System. An account of the project to consolidate several railroads into a system known by this name. Map. 1000 w. R R Gaz—April 6, 1900. No. 33461.

Denmark.

General Operating Statistics of the Denmark State Railroads for 1897 and 1898 (Danemark, Résultats Généraux de l'Exploitation des Chemins d Fer de l'Etat pendant les Exercises Terminés aux 31 Mars, 1898 et 1897). Five short tables giving general movement and expense statistics, taken from the Danish official reports. 100 w. Ann d Ponts et Chaussées—Jan., 1900. No. 33581 E + F.

Queensland.

The Railways and Trade of Queensland. Editorial discussion of the general results of the railway operations of the past year. 2300 w. Engng—March 23, 1900. No. 33392 A.

General Operating Statistics of the Queensland, Australia, Railroads for 1897-98 and 1896-7 (Australie, Province de Queensland. Résultats Généraux de l'Exploitation des Chemins de Fer pendants les Exercises 1897-8 et 1896-7). Five short tables giving general movement and expense statistics, taken from the report of the Queensland Railway Commissioner. 100 w. Ann d Ponts et Chaussées—Jan., 1900. No. 33580 E + F.

Roumania.

General Operating Statistics of the Roumanian State Railroads for 1896 and 1897 (Roumanie. Résultats Généraux de l'Exploitation des Chemins de Fer de l'Etat pendant les Années 1897 et 1896). Five short tables giving general movement and expense statistics, taken from Volume 48 of the *Statistique de l'Union des Administrations des Chemins de Fer Allemands.* 100 w. Ann de Ponts et Chaussées—Jan., 1900. No. 33582 E + F.

LEGAL.

Safety Appliances.

Safety Appliances in Mexico. Translation of the order issued by the Mexican Government requiring railroads to equip their cars with certain safety appliances. 600 w. R R Gaz—April 20, 1900. No. 33757.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Tests of Air-Braked Trains on Mountain Grades. Extracts from the report published by the Westinghouse Air Brake Company, as "Bulletin No. 7," containing important information. 3000 w. R R Gaz—April 27, 1900. No. 33840.

Bearings.

The Improved Susemihl Roller Side Bearing. Illustrated description of these roller side bearings, in use on the Michigan Central R. R. 900 w. R R Gaz—April 6, 1900. No. 33462.

Cars.

70,000 Lbs. Capacity Cars for the Philadelphia & Reading Railway. Illustrated detailed description. 1200 w. R R Gaz—April 27, 1900. No. 33845.

Coal Cars.

80,000-Pound Steel-Frame Coal Cars with Drop Doors. Illustrated description of cars for the Norfolk & Western Ry., having frames of structural steel with wooden floors and siding. 800 w. Am Engr & R R Jour—April, 1900. No. 33315 C.

Compounds.

Blows in Baldwin Compounds. Alonzo B. Kinyon. Illustrates and describes action of the Vauclain compound locomotive and explains the cause of blows and the remedy. 1500 w. Loc Engng—April, 1900. No. 33329 C.

Fuel.

Burning Oil on Locomotives. C. R. Petrie. Illustrated description of apparatus and method employed on Southern Pacific locomotives. 800 w. Loc Engng—April, 1900. No. 33330 C.

Hand Brakes.

The Efficiency of Hand Brakes on Railway Cars (Ueber den Wirkungsgrad der Spindelbremsen von Eisenbahn-Fahrzeugen). C. Schlöss. An illustrated account of careful tests made on the Austro-Hungarian Railroads. 1600 w. Zeitschr d Oest Ing u Arch Ver—April 6, 1900. No. 33551 B.

Hot Box.

Some Causes of Hot Bearings with a New Form of Brasses for Railroad Car Journals (Ueber einige Ursachen des Heisslaufens der Lager und über eine Neue Lagerschale für Eisenbahnfahrzeuge). Josef Grossmann. Discussion of the causes of hot journals, with suggestions for diminishing them. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—March 23, 1900. No. 33549 B.

Locomotives.

Brooks Consolidated Locomotives, L. S. & M. S. Ry. Illustration of engine for freight service, with general dimensions. 900 w. Ry & Engng Rev—April 21, 1900. No. 33789.

Consolidation Locomotives for the Oregon Short Line. Illustrated description, with dimensions. 500 w. R R Gaz—April 20, 1900. No. 33755.

Eight-Wheel Passenger Locomotive—Boston & Albany R. R. Engraving general dimensions and remarks. 600 w. Am Engr & R R Jour—April, 1900. No. 33318 C.

Eight-Wheel Passenger Locomotives for the New York, Ontario & Western Railway. These engines have a deep, narrow fire box designed for burning bituminous coal. Dimensions and description. 700 w. R R Gaz—April 20, 1900. No. 33756.

Freight Locomotive; East Indian Ry. Dimensions, illustration and description of an English built engine. 1000 w. Eng News—April 12, 1900. No. 33645.

Locomotive Design. E. H. McHenry. Chart of locomotive horse-power, with discussion of the curves of various engines. 1700 w. R R Gaz—April 13, 1900. No. 33646.

Schenectady Mogul Locomotive, N. Y. C. & H. R. Ry. Illustration and views showing the points of interest of these new freight engines, with particulars. 900 w. Ry & Engng Rev—March 31, 1900. No. 33361.

The Colliery Locomotive. An illustrated review of the early history of the locomotive engine, which was inseparably connected with colleries. 2200 w. Ir & Coal Trds Rev—April 6, 1900. Serial. 1st part. No. 33709 A.

Mineral Locomotives for the Port Talbot and Barry Railways. Engravings showing the details of the design, and the general arrangement, with description. 1000 w. Engng—April 13, 1900. No. 33773 A.

Norfolk & Western Freight Engines. Illustrated detailed description of the new piston valves used. They were designed by W. H. Lewis and are entirely satisfactory. 400 w. Loc Engng—May, 1900. No. 33885 C.

Prairie Type and Wide Firebox Switch Engines. Illustrated description of new types for service on the C. B. & Q. R. R. The Prairie type is regarded as an epoch-making design which will show the possibilities of a moderate widening of grates. The switch engine is believed to be the first wide firebox built for the use of soft coal. 1700 w. Am Engr & R R Jour—April, 1900. No. 33316 C.

Cast Steel Parts of the New Chicago and Alton Eight-Wheel Locomotives. Reproduced drawings and table showing the finished weights of the steel-castings used, and also the weights of similar parts in wrought iron or cast iron. 500 w. R R Gaz—April 20, 1900. No. 33754.

Nozzles.

Why Not Try Variable Nozzles? Editorial discussing the advantage of using variable nozzles. 900 w. Loc Engng—April, 1900. No. 33331 C.

Smoke.

Burning Bituminous Coal Without Smoke on the Southern Pacific System. J. Snowden Bell furnishes notes concerning the results obtained by the methods in use. Detail drawings of the mechanical features contributing to the results are given. 1800 w. R R Gaz—April 27, 1900. No. 33844.

NEW PROJECTS.

Africa.

The Railways of Africa. H. L. Geissel. Describes the railways constructed and under construction, giving information relating to them. 4000 w. Ry Age—April 6, 1900. No. 33406.

China.

Railway Opportunities in the Orient. Wm. Barclay Parsons. Considers India and Japan as prophetic of the future of China, and shows by the profitable returns from railways worked in those countries what large opportunities are opening in China. Ill. 2700 w. The Engineering Magazine—May, 1900. No. 33902 B.

Extension.

Construction of the Mississippi River Extension of the Chicago & Eastern Illinois R. R. Illustrated description of this work, its viaducts, etc. The distance is 62 miles. 1500 w. Eng News—April 12, 1900. No. 33642.

Great Central Ry.

Completing the Great Central Railway. Reviews the work that has been accomplished during the last year in completing the extension opened. 1400 w. Engr, Lond—March 23, 1900. No. 33305 A.

The Great Central Railway Extension. Abstracts of two papers on this subject, read at meeting of the Brit. Inst. of Civ. Engs. F. W. Bidder's paper referred to the line from Annesley to Rugby. F. Douglas Fox described the line from Rugby to the London terminus. 2200 w. Col Guard—April 6, 1900. No. 33708 A.

Russia.

Russian Railways. H. L. Geissel. A review of progress made and projects contemplated. 1500 w. Ry Age—April 13, 1900. No. 33672.

Sahara.

The Trans-Sahara Railroad (Le Transsaharien). G. Leugny. A general sketch, with maps of this proposed railroad from Algiers to Lake Tchad and other points in French Africa. 3000 w. Revue Technique—March 10, 1900. No. 33598 D.

Trans-Siberian.

The Trans-Siberian Railway. Information from a recent "Guide to the Siberian Railway," issued by the Russian Imperial Ministry of Ways of Communication. Shows the importance of the line, the unexpected traffic, and the great wealth of the country. 1600 w. Engr, Lond—April 6, 1900. No. 33713 A.

PERMANENT WAY AND FIXTURES.

Engine Houses.

The New Engine Houses of the Swiss North Eastern Railroad at Zurich (Die Neue Locomotiv-Remisenanlage der Schweiz. Nordostbahn in Zürich). E. Egger. An illustrated account of this locomotive house and repair shop. 1600 w. Schweiz Bauzeitung—April 7, 1900. No. 33539 B.

Painting.

Painting Railroad Bridges. Hunter McDonald. Extracts from a paper before the Engng. Assn. of the South. Describes a recent laboratory test of twenty different kinds of paint made recently by the writer. 1300 w. R R Gaz—April 27, 1900. No. 33839.

Rail Tests.

Do the Usual Acceptance Tests of Steel Rails Answer Their Purpose (Eutspricht das zur Zeit Uebliche Prüfungsverfahren bei der Uebernahme von Stahlschienen seinem Zwecke)? A. Martens. Based on articles in *Baumaterialenkunde*. A long article, with illustrations and tables, criticising existing methods, and suggesting improvements. Two articles, 8000 w. 1 plate. Stahl und Eisen—March 15, April 1, 1900. No. 33541 each D.

Shops.

Cleburne Shops of the Santa Fé. Description of large shops recently erected for locomotive and car repairs. 1200 w. Loc Engng—April, 1900. No. 33328 C.

Shops of the Mexican Central at Aguas Calientes. Plan and description of the plant, with remarks. 1500 w. R R Gaz—April 6, 1900. No. 33458.

Through Siberian Railroad Shops. L. Lodian. An illustrated description of the shops, machinery, and stations of the Trans-Siberian Ry. 3000 w. Loc Engng—May, 1900. No. 33888 C.

Signals.

Calling-on Signals at Savanna, Ill. Illustrates and describes how this signal, on C., M., & St. P. Ry., is used. 350 w. R R Gaz—April 13, 1900. No. 33647.

Extra Block-Signal Safe Guards in Time of Fog. Editorial discussing English methods, and suggesting methods of protecting trains during fog. 1300 w. R R Gaz—April 20, 1900. No. 33760.

Visibility and Confusion Tests of Signal Glasses. Brief account of interesting experiments made by Prof. Louis Derr with colored glasses for fixed signals. 700 w. R R Gaz—April 6, 1900. No. 33457.

Maintenance and Inspection of Automatic Electric Block Signals. H. S. Balliet. Read at meeting of the Ry. Sig. Club, Chicago. Describes the system and the maintenance force necessary for its efficient operation. 1600 w. Ry Age—April 6, 1900. No. 33495.

Switch and Signal.

New Signal and Safety Switches on the Prussian Railroads (Neuerungen an den Signal-Weichensicherungsanlagen auf den Preussischen Eisenbahnen). H. Scholkmann. An address delivered before the *Verein für Eisenbahnkunde*, Berlin, giving an account of recent improvements in safety appliances on the Prussian railways. Well illustrated. 4500 w. Glaser's Ann f Gew u Bauw—March 15, 1900. No. 33522 D.

Ties.

New Tie Treating Plant of the Burlington & Missouri River Railroad. Illustrates and describes the plant at Edgemont, S. D., where an average of 50,000 ties a month are treated. 700 w. R R Gaz—April 6, 1900. No. 33460.

Tie Preserving Plant, B. & M. R. Ry., Edgemont, S. Dak. Illustrates and describes a plant where the zinc-chloride process is used. Also editorial. 1500 w. Ry & Engng Rev—March 31, 1900. No. 33362.

Tie Treating. O. Chanute. Reviews briefly the history of the preservation of crossties by the injection of chemical substances. 1100 w. R R Gaz—April 6, 1900. No. 33456.

Treating Railroad Ties and Timber. A description of the method and apparatus used on the Atchison, Topeka & Santa Fé Ry., at Los Vegas, New Mexico. The Willhouse system. 800 w. Loc Engng—May, 1900. No. 33886 C.

Tools.

Blacksmith Tools in a Small Railroad Shop. Illustrates and describes some of the labor-saving tools used in the Boston & Maine shops at Springfield, Mass. 800 w. Loc Engng—April, 1900. No. 33332 C.

Transfer Tables.

Transfer Tables. Illustrates and describes a novel design at the Portsmouth shops of the Seaboard Air Line. Also the table at Parsons, Kan., in the shops of Missouri, Kansas & Texas Ry. 800 w. Ry Age—April 20, 1900. No. 33762.

Water Supply.

Notes on Railway Water Supply. W. L. Derr. Considers the sources of supply, reservoirs, dams, wells, tanks, water cranes, pumps, pipes, etc. Also discussion and illustrations. 16500 w. N. Y. R R Club—March 15, 1900. No. 33788.

Some Peculiarities About Water. Editorial on the practical value of water selection and treatment for railways. 1500 w. Loc Engng—May, 1900. No. 33889 C.

Weed-Burning.

Weed-Burning Car, M., St. P. & S. St. M. Ry. Illustrated description of car and its operation and statement of cost. 1000 w. Ry & Engng Rev—April 21, 1900. No. 33790.

TRAFFIC.

Rates.

Compensation for Carrying Mails. J. Kruttschmitt. A letter criticising deductions drawn from testimony of Henry C. Adams, and discussing rates of railway mail. 2000 w. R R Gaz—April 20, 1900. No. 33753.

STREET AND ELECTRIC TRAMWAYS

Boston Elevated.

Some Construction Work of the Boston Elevated Railroad. Edgar M. Smith. Illustrates and describes some fine work under unusual conditions. 900 w. R R Gaz—April 20, 1900. No. 33759.

Compressed Air.

Traction by Compressed Air at Paris. Brief account of the lines and their operation. 1000 w. R R Gaz—April 6, 1900. No. 33459.

Electric Traction.

Schemes for the Application of Electric Traction to Railway Lines in Italy. Giovanni Georgi. Reports many roads now being equipped for electric traction. A system of trunk lines aggregating a length of 83 miles is being equipped, also mountain roads, and others. 1600 w. Elec Wld & Engr—April 21, 1900. No. 33764.

Electrolysis.

Electrolysis. E. H. Jenkins. Read before the Southwestern Gas, Electric, and Street Railway Assn. Considers the electrolytic action and the remedies. 3700 w. Am Gas Lgt Jour—April 23, 1900. No. 33767.

Expenses.

Working Expenses of Electric and Cable Railways. Tables of working expenses, receipts, etc., of the electric and cable railways of Great Britain. 1400 w. Tram & Ry Wld—April 5, 1900. No. 33731 A.

Goods Carrying.

Hauling Freight and Express Matter on Electric Railways. A discussion of this service, with suggestions of the latest and best practice, and a description of the methods on a number of roads. Ill. 5000 w. St Ry Rev—April 15, 1900. No. 33717 C.

Interurban.

Dayton, O., as an Interurban Railway Center. Brief account of the street railways of the city, with illustrated description of the interurban lines completed and under construction. 3800 w. St Ry Jour—April 7, 1900. No. 33464 D.

Oshkosh & Neenah Interurban Electric Ry. Illustrated detailed description of a 16 mile railway, which forms an important link in the proposed electric system from Chicago to Green Bay, Wis., a distance of 198 miles. 1900 w. Eng News—April 5, 1900. No. 33449.

The Detroit, Rochester, Romeo & Lake O'rion Railway. Illustrated description of a recently completed electric railway, with information relating to its operation. 1800 w. St Ry Jour—April 7, 1900. No. 33465 D.

Japan.

The Nagoya, Japan, Electric Railway Company. T. Kogi. Brief descriptive account of the line. 800 w. Elec Wld & Engr—April 7, 1900. No. 33491.

Light Railways.

Light Railways in France. The first of a series of articles on the construction and working, considering only the practical points of completed lines. Ill. 3000 w. Engr, Lond—April 6, 1900. Serial. 1st part. No. 33710 A.

Locomotives.

New Electric Locomotives (Neuere Elektrische Lokomotiven). An illustrated description of some new electric locomotives doing heavy work in everyday practice. 1600 w. Zeitschr d Ver Deutscher Ing—March 24, 1900. No. 33556 D.

Methods.

Some Differences Between American and British City Transportation Methods. Edward E. Higgins. A statement of facts relating to street railway development in the two countries, with interesting comparison of results. 2800 w. St Ry Jour—April 7, 1900. No. 33471 D.

Mono-Rail.

Barmen Electric Suspension Railway. Illustrated description of double-railed line 8.3 miles in length, with 18 stations. 700 w. U. S. Cons Repts, No. 704—April 14, 1900. No. 33650 D.

Single Rail Suspension Railway at Barmen. Brief description with illustrations. 400 w. St Ry Rev—April 15, 1900. No. 33718 C.

The Langen Mono-Rail Suspended Railway at Elberfeld-Barmen. Editorial review of this system. Part first notes briefly the previous attempts. 1800 w. Engng—March 30. 1900. Serial. 1st part. No. 33616 A.

The Langen Suspended Railway. Translated description from the *Zeitschr. d Ver Deutscher Ing.*, of a remarkable railway system being built in Germany. Ill. 900 w. Eng News—April 5, 1900. No. 33448.

The Single-Rail Suspended Electric Railway between Barmen, Elberfeld and Vohwinkel (Die Elektrisch Betriebene Einschienige Schwebebahn Barmen-Elberfeld-Vohwinkel im Wupperthale). A description of this interesting overhead railway, with illustrations and plans. 800 w. Mitt d Ver f d Förd d Loc u Strassenbahnwesens—March, 1900. No. 33528 D.

Motor Suspensions.

Traction Motor Suspensions. Ernest Kilburn Scott. Part first illustrates and describes various forms of suspension used to avoid shock to the motor in electric traction. 1200 w. Elec Rev, Lond—April 13, 1900. Serial. 1st part. No. 33797 A.

Paris Conduit Road.

Electric Conduit Road in Paris (Unterirdische Stromzuführung für Strassenbahnen in Paris). Well illustrated description of this road, with many novel details of construction. 1500 w. Ill. Zeitschr f Klein u Strassenbahnen—March 16, 1900. No. 33576 C.

Polyphase.

Polyphase Transmission for Suburban Extensions. Discusses the advisability of installing polyphase apparatus and the proper type for long-distance extensions. 1600 w. St Ry Jour—April 7, 1900. No. 33470 D.

Power Station.

South Side Elevated Railroad Power House. Illustrated description of additions and improvements which make this one of the largest and best equipped electric power stations in Chicago. 2000 w. W Elect'n—April 14, 1900. No. 33674.

Rolling Stock.

New Rolling Stock for the Waterloo and City Railway. Illustrated description of motor cars for special requirements. 1300 w. Tram & Ry Wld—April 5, 1900. No. 33730 A.

Single Rail.

See Mono-Rail.

Subway.

The Extension of the Orleans Railroad from its Walhubert Station to the Quai d'Orsay in Paris (Ueber die Verlängerung der Orléansbahn von ihren Endbahnhofe Walhubert nach dem Quai d'Orsay in Paris). E. A. Ziffer. An illustrated account of the 2½ mile extension of the Orleans Railroad along the left bank of the Seine, in Paris. 5000 w. 1 plate. Mitt d Ver f d Förd d Loc-u Strassenbahnwesens—March, 1900. No. 33527 D.

Tests.

Electrical Tests of the Boston Elevated Railroad. An account of the tests made to determine what system for controlling the motors from one point was best adapted to the trains. 1600 w. R R Gaz—April 27, 1900. No. 33843.

Three-Phase.

Three-Phase Transmission on the Union Railroad, Providence, R. I. Burcham Harding. Describes the means taken by the road named to solve the problem of furnishing power upon economical terms for an extended line. Ill. 2000 w. St Ry Jour—April 7, 1900. No. 33467 D.

Underground Trolley.

Grounds on Underground Trolley Railway Systems. An unusual arrangement of the circuits is necessary to prevent short circuits, and the article describes the connections and operation of the switchboard. Ill. 3000 w. St Ry Jour—April 7, 1900. No. 33468 D.

Western Australia.

The Electric Tramway System of Perth. Illustrated detailed description of a road with interesting features. 1500 w. St Ry Jour—April 7, 1900. No. 33466 D.

THE WORLD IS ITS FIELD.

THE ENGINEERING MAGAZINE

VOL. XIX. JULY, 1900. NO. 4.

ENGINEERING DEVELOPMENT OF THE FAR EAST.

By Wm. Barclay Parsons.

EVERY one knows that the Chinese once led the world in scientific and material development, but that they were acquainted with the principles of good engineering design was a surprise to me. At the seaports where foreigners have resided, or even in those portions of the Empire into which foreign ideas might have penetrated, it was expected to see structures bearing the imprint of modern skill in design or construction; but it was not expected to find such things in the unexplored interior, remotely or entirely removed from outside influences, and of such self-evident age as to stamp them as genuinely Chinese, both in workmanship and plan.

The structures that impress the engineering observer most strongly are the bridges, the pagodas, the city walls and certain details of building construction. The arch, that beautiful structure from the scientific as well as the æsthetic point of view, is generally believed to be of Roman origin. It was not known to, or at least never used

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Mr. Parsons' article—the third of a striking series just published in THE ENGINEERING MAGAZINE—puts in concise and almost epigrammatic form his conclusions as to the promise the great empire of China holds for the western engineering world. It is "the richest commercial prize of the age." Interest in Far Eastern affairs grows tense with recent news from Pekin, suggesting that the hopeless mediævalism of China's court would try a definite issue with fast advancing material civilization. This is discussed more fully in the Editorial Comment in this issue.—THE EDITORS.

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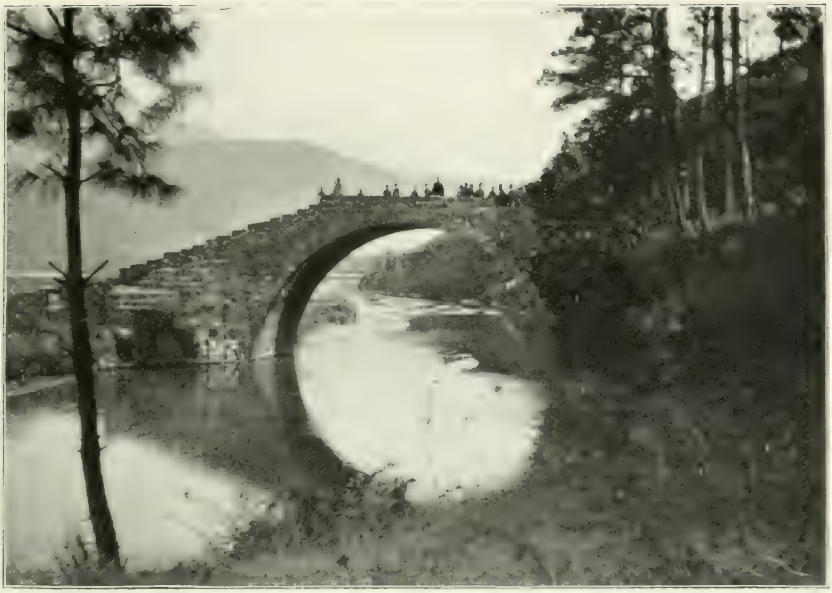
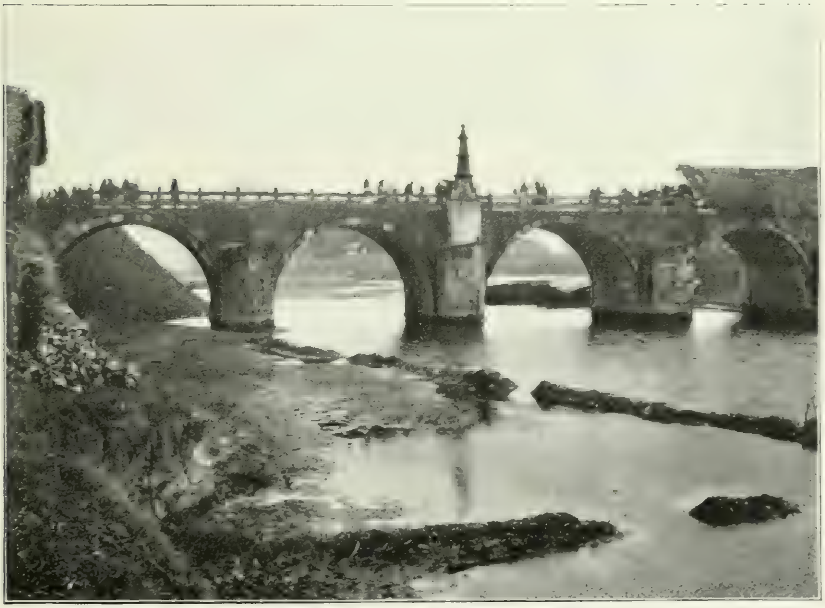
by, the Greeks; and although the shape appears in certain specimens of Hindoo architecture, it is of false variety—that is, a succession of protruding corbels. In China, on the other hand, we find it of most widespread and general application, and examination shows that the principles involved are thoroughly understood, as the arches are composed of a complete ring of voussoirs, radially jointed and of proper proportions. Moreover, the arch ring is always continued down to the spring, and not built in connection with the spandrels, as is commonly done elsewhere. The general use of the design in all parts of the country and the undoubted antiquity of so many of the existing examples clearly demonstrate that it long antedates any possible foreign suggestions, and go a long way to establish it as of Chinese origin—a development, however, which, like printing and gunpowder and so many other inventions and discoveries, never passed beyond the national borders.

A VERY OLD STONE ARCH.

The largest application of the arch principle is in the building of bridges, where spans of thirty to forty feet are common, while single spans of fifty feet are seen and larger ones probably exist. Longer spans than these are not usually required, as those streams which can be bridged do not, as a rule, call for single openings larger than will suffice to pass small boats. The arches are usually of the

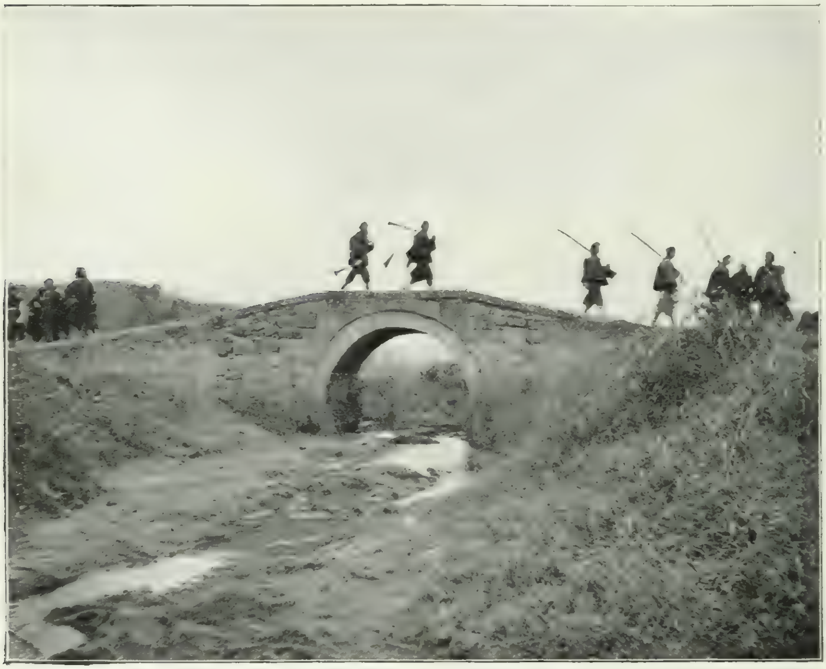


A FINE SINGLE SPAN.



PING HSIANG BRIDGE, A PERFECT SPECIMEN.

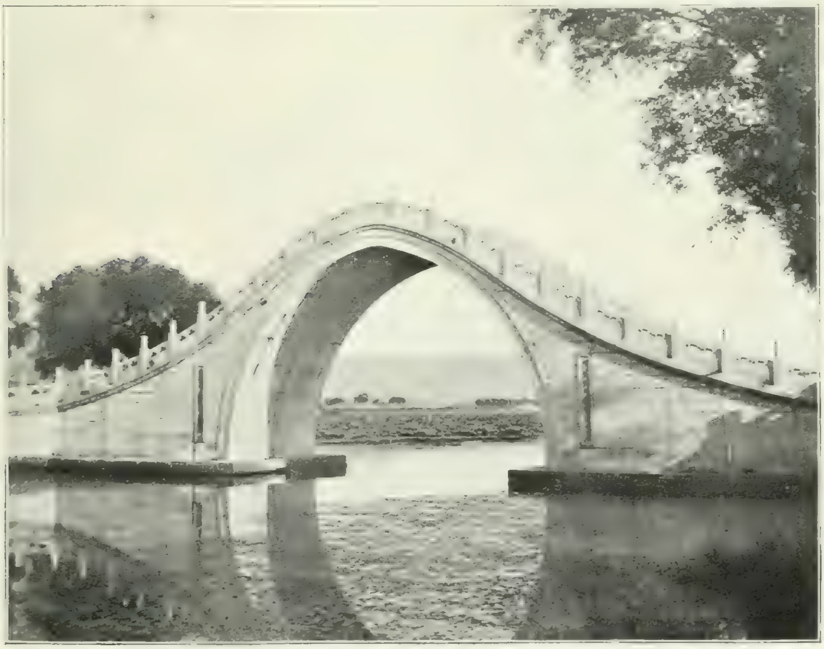
full half-circle, with the spring above the ordinary flow line. The arch joints are cut close and filled with hard, firm mortar, while the spandrels are always built independently of the arch, and usually of inferior workmanship, indicating clearly that the designer understood the theory. The piers frequently have V-shaped ends up stream, probably to diminish scouring action and to prevent drift trash from catching, as such additions are common even in the southern districts where ice is unknown. The roadway is guarded by carved railings in the case of the more elaborate structures, or by a solid parapet, some of the latter that I saw being composed of concrete. These arches have a grace of outline based on proper proportion, a solidity in appearance from good construction, coupled with a very evident sound application of theory to practical uses in accordance with the requirements of local conditions—considerations that stamp them as construction works of a very high order, although their size, as compared with arches in other lands, may be small.



THE STONE ARCH USED FOR A CULVERT.

With the freedom that a designer takes when he is sure of his principles, some of the Chinese arches take extraordinary shape, such as the single span near Peking, carried to a height seemingly out of all proportion in order to pass boats with short masts; and yet, such a design, in a locality without wheeled vehicles where a short excessive gradient is not a serious matter, not only meets the requirement of economical planning but adds also the charm of irregularity, which, in a country distinguished for sameness and lack of contrast, is especially attractive.

The Chinaman is very much like a cat—he objects to getting his feet wet; and as he carries his own loads, which he thinks he can do more cheaply than by horse or carriage, he sees to it that all streams are bridged. The arch he uses nearly always in the large structures, and carries it down in the scale even to small culverts; although, when he begins to deal with little openings, he frequently makes use of stone stringers. If suitable stones can be procured he does not hesitate to be bold, as some beams I measured were 30 feet long and 15 inches deep. In other instances the effective spans were made shorter by placing corbels beneath the ends of the stringers, and occasionally intermediate supports were furnished by framed bents of long stones, exactly like the ordinary American timber construction.

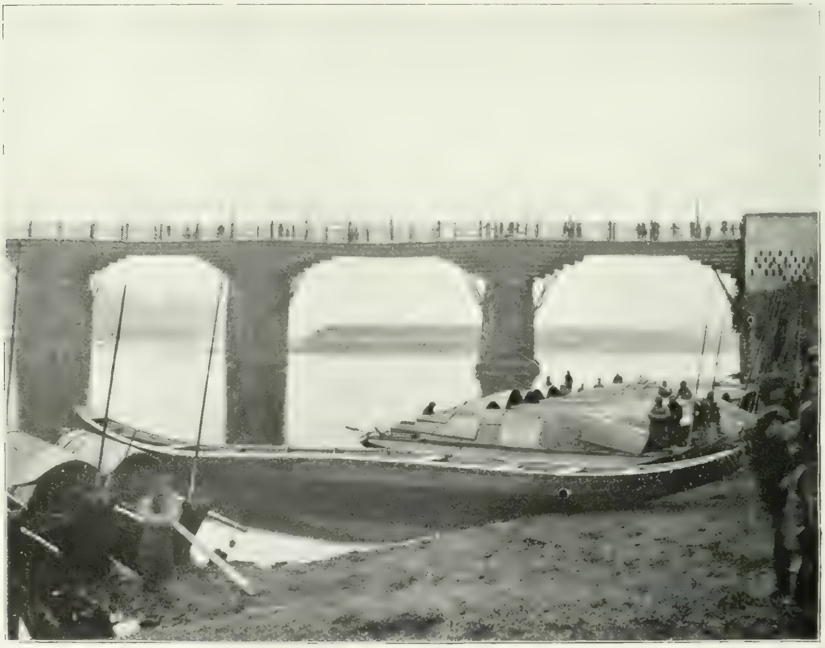


BRIDGE OF CHINESE DESIGN AND CONSTRUCTION NEAR PEKIN.

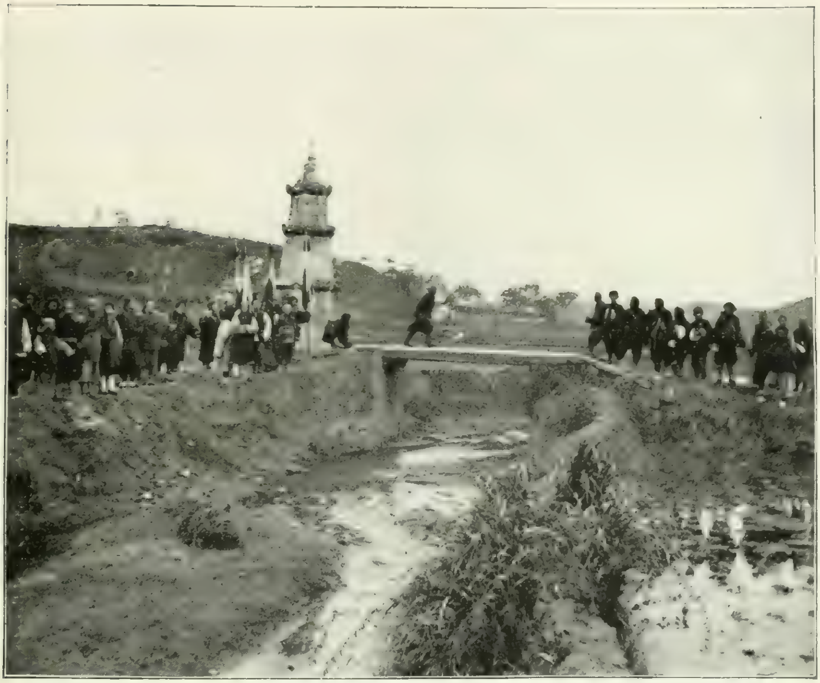
Designed to allow the passage of masted junks.

But the most remarkable bridge I saw was a wooden cantilever, in the eastern part of Hu-nan, the most anti-foreign section of the whole empire, and in a part of that province which no white man had ever previously approached. This bridge consisted of six spans, with a length of 480 feet and a width of 20 feet, paved with cobble stones, while a frame is in place to carry awning mats in summer. The substructure is masonry piers in good condition, but evidently of good age, while the superstructure is of wood and a genuine cantilever in design. It is constructed with layers of timbers, alternating in direction at right angles to each other, and so building out the arms from the piers until the intervening space is short enough to be spanned by a single piece. The superstructure is not so old as the substructure, the timber having been undoubtedly replaced, possibly many times; but it was, when visited, in horrible condition of decay. It will stand, however, without repairs or attention—as all structures in China are allowed to go—until some day an extra-large crowd will be too much for the rotten timbers to hold up and it will collapse with great loss of life.

From the point of view of artistic and essentially Oriental design the pagoda possesses the most interest. These singular constructions, at least one of which nearly every city possesses, fairly dot the

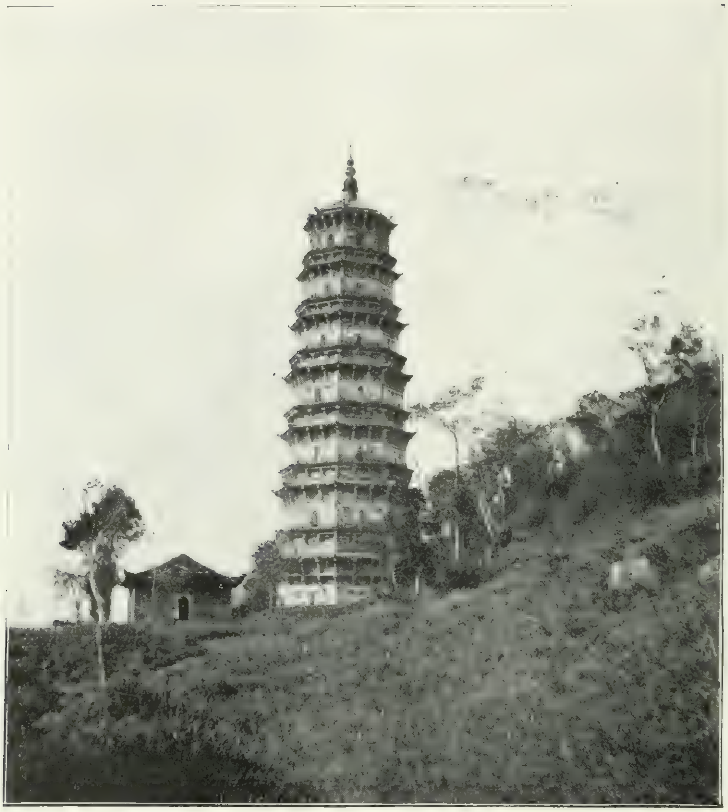


LI LING CANTILEVER, BUILT OF WOOD



STONE STRINGER AND SMALL PAGODA.

surface of the country. Their purpose appears to be twofold—either as monuments commemorating the virtues or the munificence of some departed benefactor, or as agents of "fêng shui" (literally "wind and water"), the spirit genius of good and evil, which, if properly propitiated, will ward off pestilence and famine and permit only prosperity and happiness to visit the neighborhood. These very curious towers are of great antiquity, Chinese records authenticating their origin at least as far back as the early part of the Christian era. In size they vary from the little ones, which are nothing more than roadside shrines, to what was once the most beautiful and largest—the celebrated porcelain pagoda of Nanking, destroyed in the Taiping rebellion. This extraordinary structure had a height of 261 feet, was built of masonry and covered with glazed tiles of many colors, and was a monument to native skill in erection as well as to artistic sense in design. Unfortunately, most of the large pagodas are being allowed to crumble to decay, although some are tended and give hope of standing for other generations to admire. The prominent ones vary in height from 100 to 200 feet, are usually octagonal in plan, with

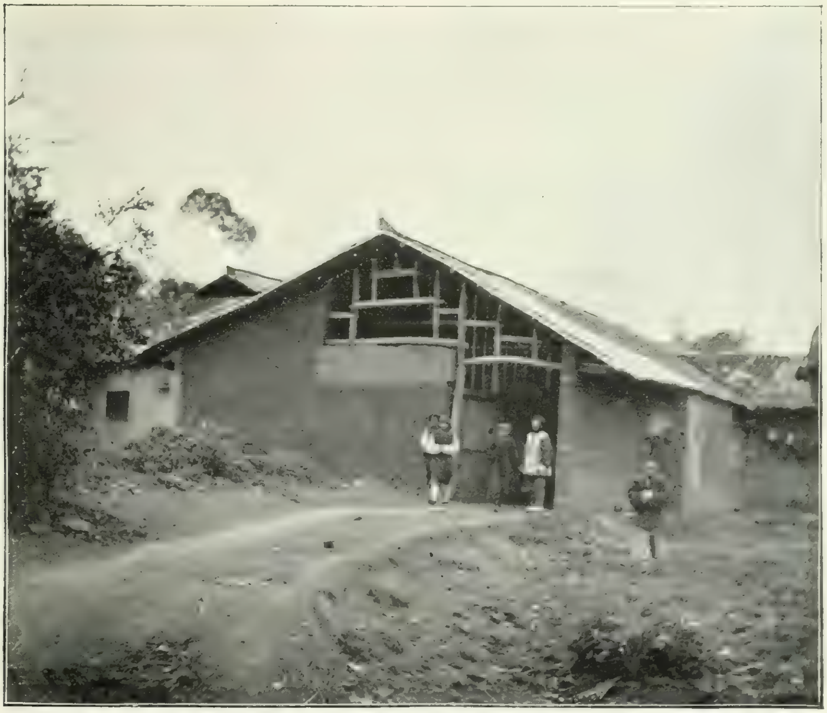


WU CHANG PAGODA.

straight but tapering sides, and always are composed of an odd number of stories; although sometimes these stories are double ones, as in the case of the Wu-chang pagoda, one of the most beautiful and best preserved in the country. They are always plumb, and if now in bad condition, it is the result of lack of care and the ravages of time and not of original faulty construction. Chinese houses conform to certain general types; therefore, in its wide range of size and of decorations, from the severely plain stone structure to the one covered with colored tiles, the pagoda marks one of the few breaks in the characteristically national rule of uniformity and furnishes as well an interesting construction study.

The method of putting up buildings with a rigid frame and then encasing them with thin masonry walls is supposed to be something essentially American; but, like so many designs claimed as modern, it finds a universal application all over China. Although the Chinaman has everywhere at hand brick-making clay, the product is not good, owing to his unfortunate tendency to over-economy—which, in this particular case, takes the form of insufficient burning. To give sufficient rigidity, house walls have to be made thick, and thick walls he found, as we have found, encroach seriously on floor space; therefore, he has developed "cage construction." The materials employed are usually round timbers, connected by mortise and pin joints, while the roof truss is a peculiar and ingenious combination of beams, taking load near the abutments only. The accompanying illustration shows such a building in process of being encased.

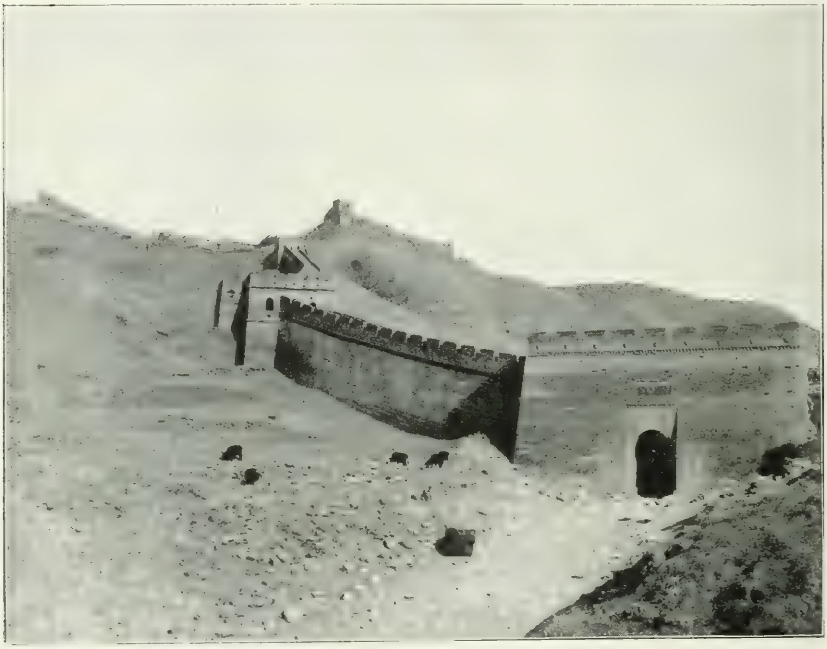
If the arches display a knowledge of theory, the houses are ingenious applications of practice, and the pagodas an appreciation of the beautiful. The walls, without which no large city in China exists, and which reach their maximum in Peking or in the even more famous Great Wall, are an evidence that our Oriental friend was equally at home with large construction. These great structures, with



AN EXAMPLE OF CHINESE CAGE CONSTRUCTION.

their massive proportions (as in the Great Wall, with its length of 1,500 miles across wild hills and desert valleys), with their keeps and arched gateways, with their parapets and moats, fill the observer with admiration.

That the Chinaman has been in the past an engineer of no mean ability, there is no question; but it will be asked: What of the future? Is he going to let things rest as they are, or will he set about to learn the newer forms of applied science, especially in the direction in which he is most deficient—improved and modern methods of transportation? Will he appreciate the necessity of railroads and steamboats, and if instructed will he use them; and, furthermore, when he has working examples to study, will he go ahead on his own account and construct and operate his own lines?



A PART OF THE FAMOUS GREAT WALL.

The engineering progress of the Chinaman has been along static rather than dynamic lines—that is, he has learned how to construct bridges, erect pagodas, and concentrate his forces to build a wall fifteen hundred miles long, but not how to construct a machine, nor to do any of the things the basal principle of which is *movement*.

Perhaps this is due to the similar traits that we find forming the framework of his national character; or, perhaps, it is due to his dread of displacing manual labor and his baseless fear of depriving his fellow man of work. But no matter the cause, this marks the cleavage line along which foreign inspiration in the art of construction will find an outlet for development.

In solid, stationary structures, the Chinaman can supply his own needs unaided; but the field for producing those aggregations of engineering and mechanical skill based on the theory or application of movement, especially of economical movement, lies unbroken and the soil is rich. The idea of economy of movement is absolutely lacking in the Chinese—a singular circumstance, as there is no other nationality so strongly economical, even to the point of parsimony. This trait is shown in his dwellings, in his clothes, and in all his details of living, except in those where movement is the main theme. The development that is to come will be, therefore, along this line, and will show itself primarily in methods of moving people and goods—namely, in means of transportation; secondly, in the methods of moving the great untouched mineral wealth from its existing subterranean hiding places to the surface, that is, in mining; and thirdly, in all matters of construction whose parts are moving—namely, machines.

PEKING WALL AND GATE.

The first of these is self-evident, and has already been treated in my article upon "Railway Development in the Orient," which was published in the May issue of THE ENGINEERING MAGAZINE. The development has already begun. The second, mining, is about to begin, but is dependent on one form of the devices under the third head—the means of moving water. The third class is general in its character and will include all kinds of machines, of which the most important class is hydraulics.

The science of handling water is practically unknown in China; the Chinese pump is a most crude and uneconomical device, and wholly incapable of raising water to a height above that of a few feet, and the lack of proper and efficient devices has absolutely prevented the development of China's mineral resources. Mining by native methods has consisted in sinking a shaft or an inclined drift down the vein until water was encountered, or until coolies could no longer raise the load on their backs, a limit in the latter case of about 200 feet. When one of these contingencies is reached the mine is abandoned. In order to develop the mineral wealth, the first requisite is a pumping plant; the second, of much less importance, is elevating machinery. The pump, however, will find many applications other than those involved in mining, namely, in supplying the crowded cities with water, for protection against fire (a source of great annual loss), and, where aided by automatic appliances, such as wind mills, for irrigation, or the reclamation of low lands subject to annual inundation.

If, therefore, I were asked to enumerate the relative importance of engineering development, I should reply—means of transportation; hydraulic machinery; mining; and then, those machines which can compete against a very low-priced manual labor, and which can, if possible, enter a field of work not now undertaken, such as electric lighting, or enter the existing fields so as to change present conditions without too violent or immediately revolutionary effects.

THE SHIP-BUILDING YARDS OF THE UNITED STATES.

By Waldon Fawcett.

THE opening of the new century will find the ship-yards of the United States occupying a position as a factor in the world's producers of naval and mercantile tonnage which certainly could scarcely have been anticipated a few years ago. The best informed men in the industry estimate that the growth during the closing three years of the century will be fully equal to that of any decade which intervened between the inauguration of metal-shipbuilding on the western side of the Atlantic and the year 1898. A review of the number of ship-building companies which have been incorporated and the new plants which have been established within the interval named would seem to afford justification for the claim.

The United States have commenced the present fight for a foremost place among ship-building nations—a struggle upon which they are now fairly entered—under conditions somewhat different from those which obtained in the case of other nations, or even from those existing in America when the clipper ships gained for her the supremacy of the seas. Great natural storehouses of material in the American forests gave the new nation a considerable advantage, and this was augmented by the impetus given to Yankee inventive ability by the emoluments certain to accrue to the builder of a speedy and powerful privateer. On the other hand, Great Britain in the early development of the metal vessels had the field largely to herself, and she in turn had the advantage of superior sources of material supply. Recognition may well be made at the outset, therefore, of the fact that the United States are seeking to regain their position in the shipbuilding world under the fiercest competitive conditions; and while

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The revival of American ship-building is to be traced not to any artificial stimulus of subsidy or protection, but to the free natural expansion of wonderful resources of material and to the constant study and use of means for labor-saving. It is along these lines that the United States must look for further progress. The long-torpid industry is already awakening, and Mr. Fawcett's rapid review of its strength is very valuable. His paper will be continued in the August issue of THE ENGINEERING MAGAZINE.—THE EDITORS.

the recent execution by American builders of Japanese and Russian naval contracts may not have the significance which has been attached to it in certain quarters, it is not without moment.

Enumerating all ship-building plants of whatsoever magnitude, and whether engaged in the construction of wooden or metal vessels, there are in the United States more than 325 ship-yards. Of this number something more than 250 are located on the Atlantic and Pacific coasts and the inland rivers, while about 75 are situated on the great lakes and the connecting waterways. The total just given, while it includes a number of builders of yachts and small craft of every description, makes no account of the engine and boiler manufacturers whose work is almost exclusively of a marine character, although a number of them frequently contract for the construction of vessels, sub-letting the contract for hull construction. There are 85 of these engine and boiler manufacturers on the Atlantic and Pacific coasts and an even greater number on the great lakes.

That the ship-yards of the country are in a generally prosperous condition is indicated by the fact that, during the last six months of 1899 and the first four months of 1900, there was only one failure among firms operating plants of any magnitude. On the other hand, a number of ship-building establishments which had been closed for some time were re-opened, and there was scarcely one of the more prominent institutions which did not inaugurate enlargements or improvements, these extensions amounting in some instances to a virtual doubling of the capacity of the yard. Most significant of all is the fact that, in the interval mentioned, there were projected ten new ship-building corporations which propose to erect plants entailing outlays ranging all the way from $500,000 to $6,000,000. Some of these new projects are already well advanced, and if all are carried out on the lines mapped out the aggregate expenditure will exceed $20,000,000.

The contracts in the hands of the American ship-builders afford an equally satisfactory showing. There are now building or under contract in the ship-yards of the United States mercantile and naval tonnage which represents an aggregate value, exclusive of the armor and armament for the naval vessels, of $69,000,000. Of this total, the naval vessels building for the United States Navy Department foot up, in round numbers, $34,500,000; the two Russian war vessels, building at the yard of Wm. Cramp & Sons Co., $5,000,000; the mercantile vessels on the Atlantic and Pacific coasts, $18,000,000; the mercantile vessels on the great lakes, $10,000,000; and the mercantile craft on the inland rivers, $1,500,000.

Comparing this showing with the volume of business on hand in the early summer of 1899, we find a distinct gain of $7,000,000 in the value of contracts, inasmuch as the commissions in the hands of the builders at that time amounted to an approximate $62,000,000. That the growth of the industry is, moreover, even greater than evidenced by these figures may be appreciated by a comparison of the sundry items which go to make up each total. The $62,000,000 worth of work on hand in the summer of 1900 was made up of naval contracts amounting to $42,000,000; mercantile vessels in the inland river yards valued at $800,000; mercantile vessels building on the lakes, $3,000,000; and mercantile vessels building on the Atlantic and Pacific coasts, $16,000,000. It will thus be seen that whereas the volume of naval work fell off $8,000,000, without taking into consideration the Russian contracts, the value of the ships building on the inland rivers was almost doubled; the aggregate of contracts at the great lake yards was more than trebled, and the plants on the Atlantic and Pacific coasts show an increase of many per cent. in the commissions on their books.

GENERAL VIEW OF THE PLANT OF THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY, NEWPORT NEWS, VA.

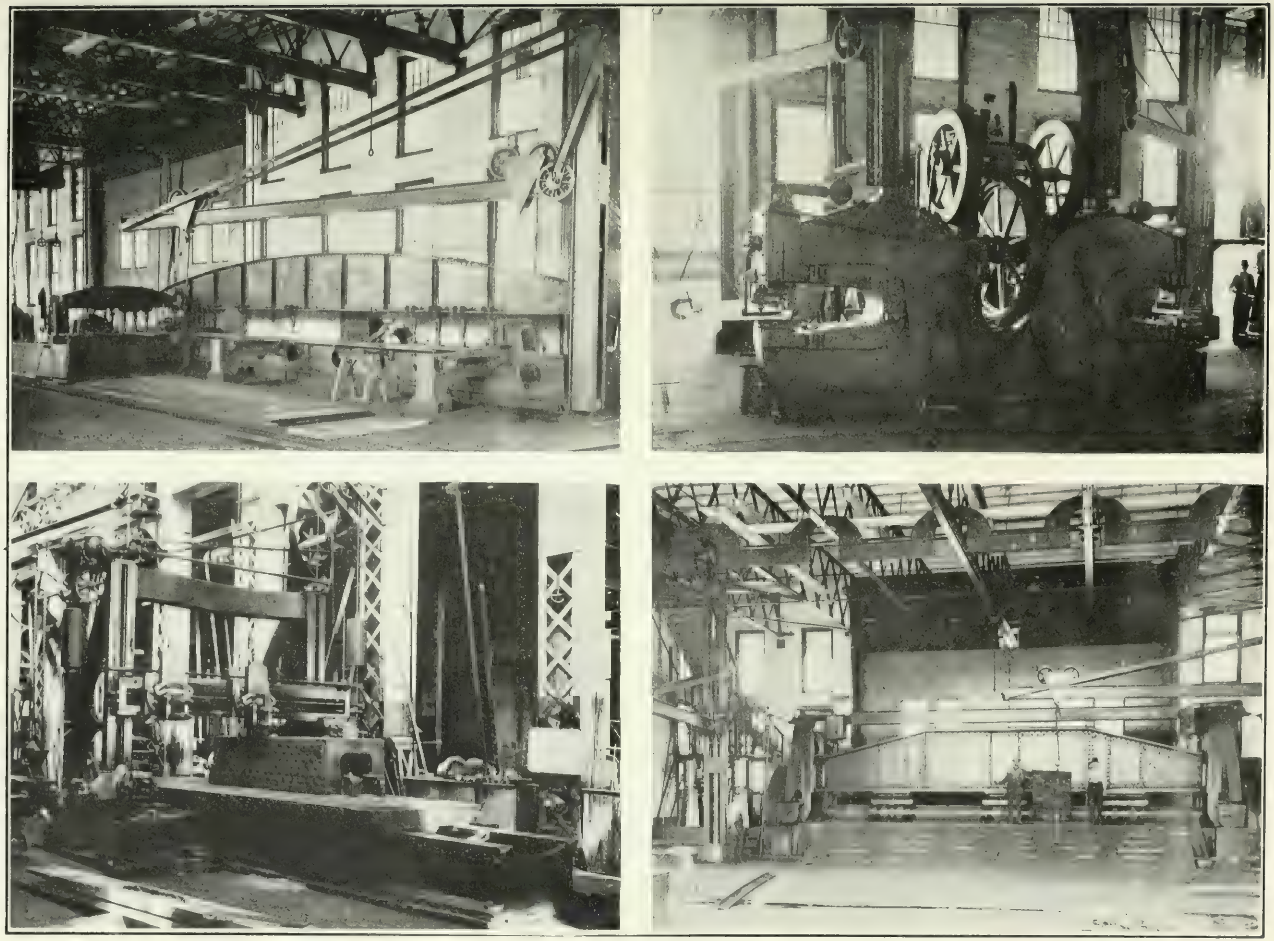
The ground for the claim that an estimate of the development of American ship-building must not be based solely on the $7,000,000 increase of the year 1899-1900 over the year 1898-99 is found in the contention that the drop in the volume of naval work is but temporary. The United States government is carrying out a fixed policy for the continual increase of the navy—is, indeed, adopting a more extensive naval programme each year, and the apparent falling-off in the amount of naval contracts in the hands of ship-builders is due to the periods at which the compilations of statistics happened to be made, rather than to any policy of retrenchment on the part of the government.

The ship-yards of the United States, unlike a great portion of those in Europe, may be divided into general classes. In the case of the plants on the Atlantic and Pacific coasts, these are four in number. In the first class may be placed the Newport News Shipbuilding & Dry-Dock Co., of Newport News, Va., the William Cramp & Sons Ship and Engine-Building Co., of Philadelphia, Pa., and the Union Iron Works, San Francisco, Cal. These build the largest and heaviest of mercantile and naval tonnage. To the trio enumerated it will be necessary to add, within the year, the New York Ship-Building Co., which is erecting a very pretentious plant at Camden, N. J., the Eastern Ship-Building Co., of New London, Conn., and possibly one or two other new concerns if the projects are carried out as contemplated.

In the second class may be placed those ship-building companies which, to a certain extent, make a specialty of the construction of cruisers, monitors, torpedo craft, and other naval vessels of the intermediate class. In passing, too, it may be noted that several of these institutions are so rapidly extending the magnitude of their operations as to suggest the probability that they will ere long be entitled to places with the first-mentioned yards.

The third class of coast yards is made up of those which, while handling an occasional torpedo-boat contract, are devoted principally to mercantile craft, notably passenger and freight steamers for coasting service, and other similar vessels. Some of these plants also make a specialty of high-class steam-yacht construction, and particularly has a tendency in this direction been manifest during the past few years. In the final class might be listed all of the smaller plants.

On the inland rivers, there are practically but two classes of ship yards—those which in the operations are confined to the construction of wooden vessels, and those which turn out both steel and wooden hulls. On the great lakes, also, a general division separates the yards into two general classes. In the plants of the one are constructed the large freight and passenger steamers ranging from 300 to 500 feet in length, while in the yards of lesser importance there is the same wide range of work that is found in the plants of corresponding size on the coasts. Among the builders of large vessels on the lakes, not a single firm devotes its attention exclusively to wooden construction.



32-foot plate-planer in the ship-shed.
20-foot planer in the machine shop.

48-inch double punch and shears in the ship-shed.
30-foot hydraulic bending rolls in the ship-shed.

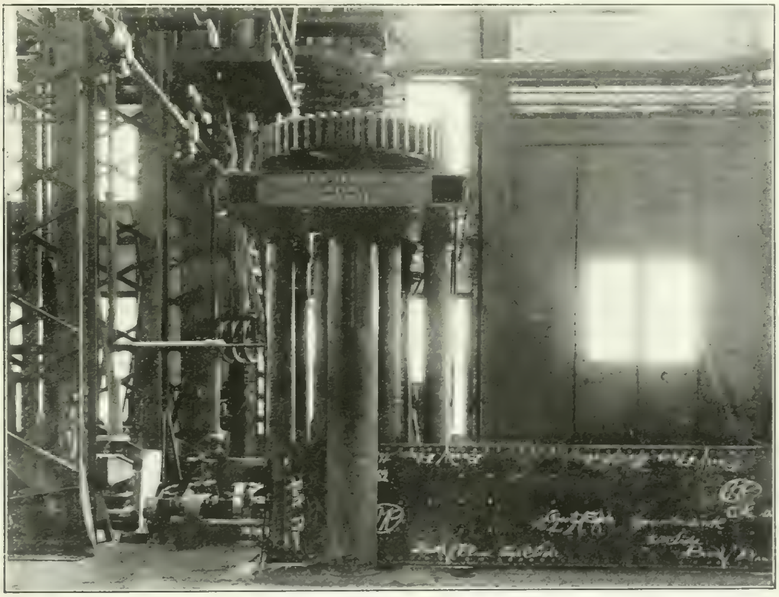
LARGE TOOLS IN THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY'S YARD.

The plant of the Newport News Shipbuilding & Dry-Dock Company is one which has attracted a considerable degree of attention during recent years, by reason of the policy of the management to carry out the most approved modern practice in the matter of equipment and its efforts to devise means to expedite the handling of material in every way possible. The ship-yard, which is located on Hampton Roads—one of the finest natural harbors in the world—covers an area of 120 acres with a mile of water front, and represents an expenditure of $12,000,000. Although the Newport News yard is unrivaled anywhere in the world in the matter of convenience, speed, and economy in the conduct of its operations, the fundamental plan is simple in the extreme. It is based on a continuous, unretarded movement forward of the material from the time it enters the yard in the raw state until it is ready to leave as a part of a completed ship. To this end the various buildings have been grouped in accordance with a carefully-devised plan. The ship and framing sheds and other departmental buildings are located near the stocks where the new vessels are under construction, and thus the material destined for the hull department may be transferred by short hauls. The machine, blacksmith, boiler, and joiner shops form another group, facilitating the handling of material for the department of boilers and machinery.

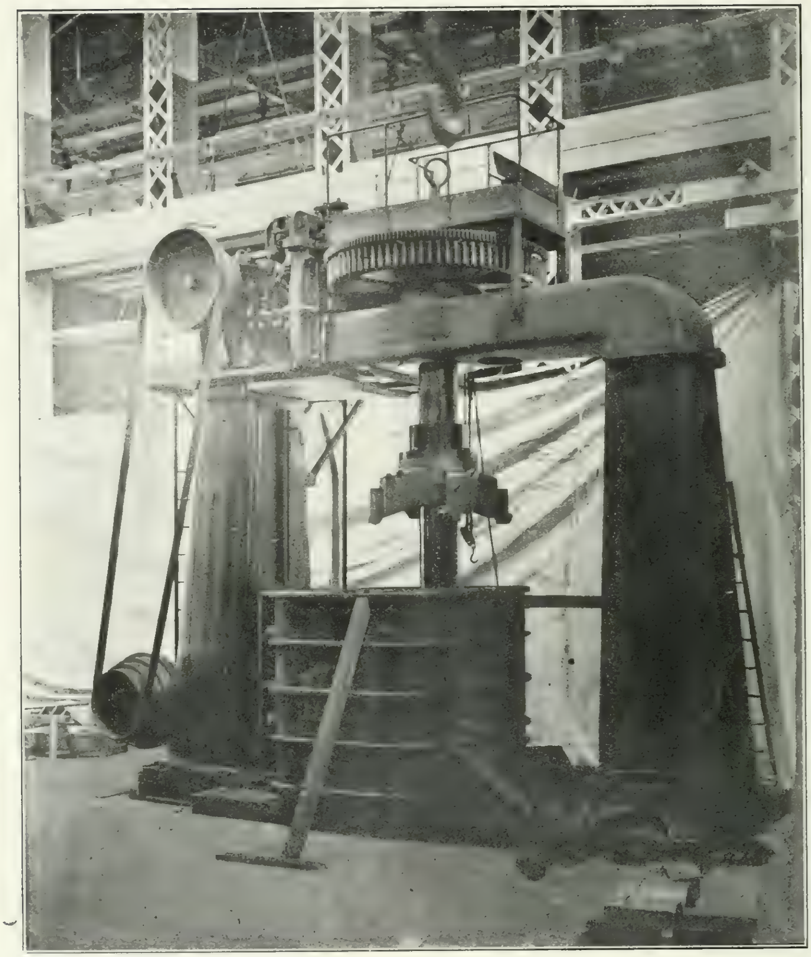
To go into detail regarding either the buildings or the machinery equipment of the Newport News works is out of the question, although both are deserving of mention. The former are substantial, and they are sufficiently commodious to enable nearly all of the 6,000 employees of the plant to be kept busy under cover in inclement weather, although this is rare in the climate. In the framing shed is a hydraulic manhole punching machine which is accounted the heaviest of the type in the United States. With a pressure of 1,500 pounds it punches a manhole 18 by 27 inches in size, from plates fully ¾ of an inch in thickness. In the grinding room are eight emery wheels, ranging in size from 9 to 36 inches. There are, in the ship shed, 32-foot bending rolls, driven by a 50-horse-power engine and regulated by hydraulic power, which are the largest in the world. The blacksmith shop has more than a dozen steam hammers, ranging from 600 to 2,500 pounds, and one of the heaviest cutting shears ever made, the maximum dimension of cut being 4 inches.

The machine shop alone, a three-story structure about 500 feet in length by 100 feet in breadth, contains an equipment of machine tools which represents a surprisingly heavy investment. There are 36- 60- and 84-inch planers, and a wall planer, measuring 22 feet plane by 22 feet slot, which has no parallel anywhere in the world. This machine, which is a combined planer and slotter, is operated by an electric motor of 50 horse-power. A 125-inch shafting lathe will take 34 feet between the centers and has a swing of 125 inches, and a 63-inch lathe, also included in the equipment, takes in a shaft 75 feet long. In the machine shop are electric traveling cranes of 40 and 50 tons' capacity, respectively, and a number of 5-ton hydraulic cranes on piers.

Included in the machinery installation at the main power-house are two air compressors of 350 horse-power each, for driving the very complete equipment of pneumatic tools with which the yard is supplied, and three 600 kilowatt generators driven by three vertical cross-compound engines, two 125 kilowatt generators driven by one horizontal tandem-compound engine, and two 75 kilowatt generators driven by simple engines. This electrical outfit furnishes sufficient power for running all of the yard shops, in which the old steam engines have recently been replaced by electric motors, furnishes current for the 2,500 incandescent and 150 arc lights which comprise the lighting plant of the yard, and also furnishes power for driving the large centrifugal pumps for emptying No. 2 dry dock. Other machines in the power house are two annealing machines of 30 horse-power each for annealing armor plate, and one 60-horse-power annealing machine,



10-FOOT ROLLS IN THE BOILER SHOP OF THE NEWPORT NEWS YARDS.

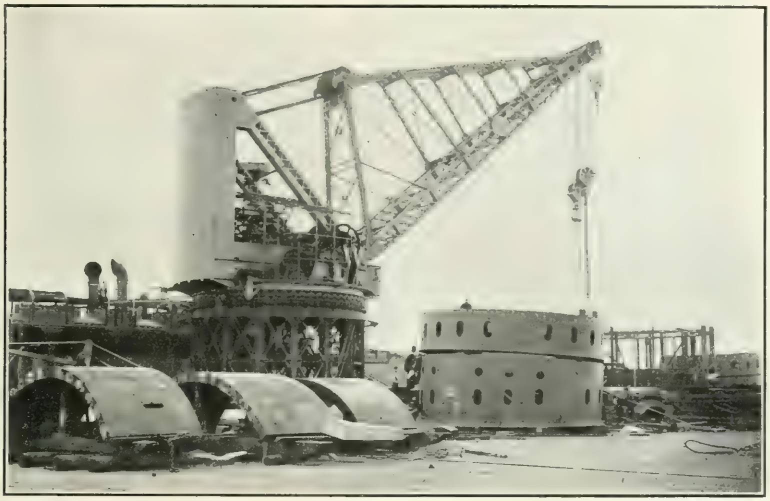


110-INCH BORING MILL IN THE MACHINE SHOP OF THE NEWPORT NEWS SHIPBUILDING AND DRY-DOCK COMPANY.

together with two 150-horse-power electric generators for supplying power for the operation of the revolving derrick, of which mention will be made later. The steam plant of four large Scotch boilers, arranged in two batteries, each on an independent stack, not only generates steam for use at the main power house, but also supplies the small independent engines installed in various departments for the operation of special machines. This steam is conveyed through an iron subway about 8 feet in diameter and 600 feet in length.

The yard is provided with two dry-docks, the smaller of which is

610 feet long and 130 feet wide on top, 50 feet wide at bottom, with a draft of water over sill of 25 feet; and the larger one, which is now nearing completion, is 827 feet long and 162 feet wide on top, 80 feet wide at bottom, with a draft of water over sill of 30 feet.



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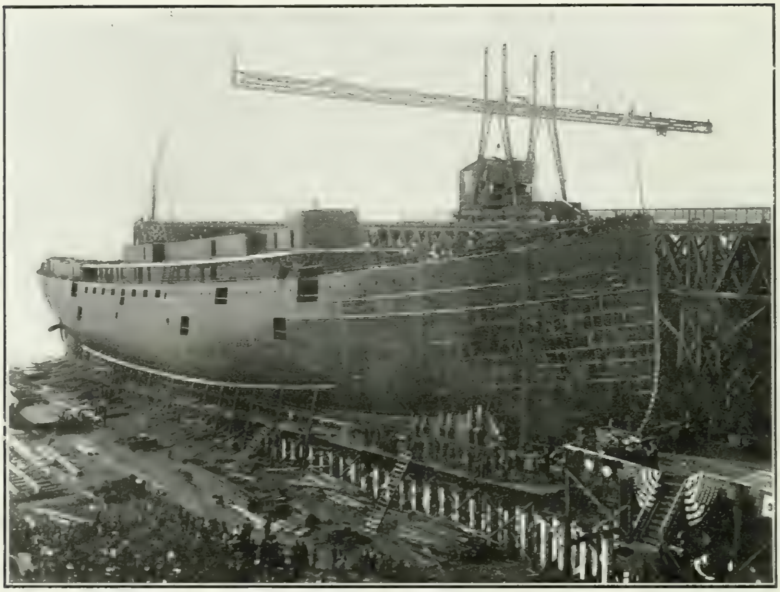
THE 150-TON ELECTRICALLY-OPERATED REVOLVING DERRICK HERCULES.

Newport News Shipbuilding and Dry-Dock Co.

The lumber department of the Newport News yards is probably the most complete in the world. There are single sheds with a capacity of 500,000 feet of lumber, and the entire lumber yard covers an area 500 by 900 feet. There is usually stored here between 4,000,000 and 5,000,000 feet of lumber, embracing thirty-six different kinds and ranging in value from $100 to $500 per 1,000 feet. Connected with the lumber department is a fire-proofing plant with five kilns. The lumber is handled in the yard by a 7-ton locomotive crane. Most of the steel and other material arriving at the yard is handled by a 5-ton crane of the same type. It may be mentioned, in passing, that all metal in storage in the yard is racked to prevent rust.

In view of the attention which the management has given to the question of the handling of material, it is quite natural that the equipment of derricks and cranes should constitute one of the most interesting features of the Newport News yard. First place must be given, of course, to the 150-ton revolving derrick Hercules. The derrick jib is capable of having its outer end raised or lowered, thus giving to the hoisting blocks, which depend vertically therefrom, a movement of

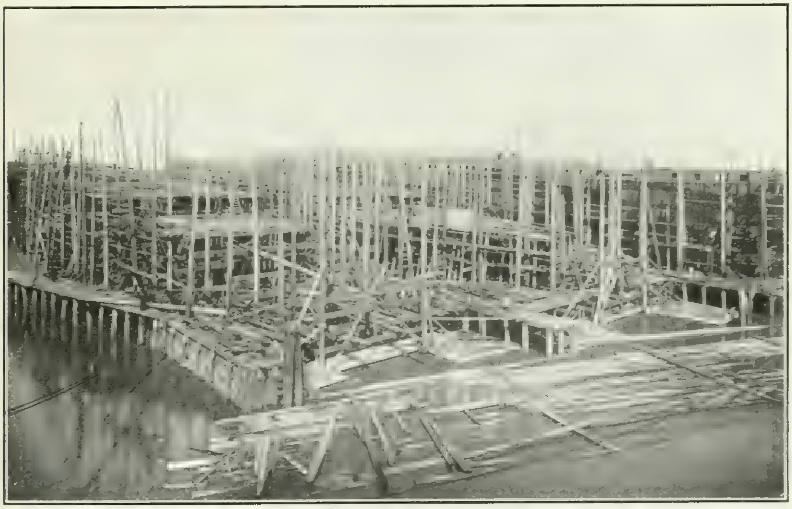


ONE OF THE TRAVELING CANTILEVER CRANES AT NEWPORT NEWS.

rotation about the center of the derrick, and also one of translation in and out from the center. With the outer end of the jib in its lowest position the hoisting blocks will, on rotation of the derrick, describe the circumference of a circle 207 feet in diameter; with the jib in its highest position, the diameter of the circle described is 88 feet. Thus the derrick may operate on weights lying anywhere between these two circles as boundaries. The maximum load of 150 tons can be handled only within a ring the maximum and minimum diameters of which are 147 and 88 feet respectively, but weights not exceeding 70 tons may be handled throughout the entire field of operations. The maximum elevations above mean high water, for the hoisting blocks, are 118 and 69 feet respectively in the high and lower positions of the jib. The derrick is revolved by duplicate sets of machinery.

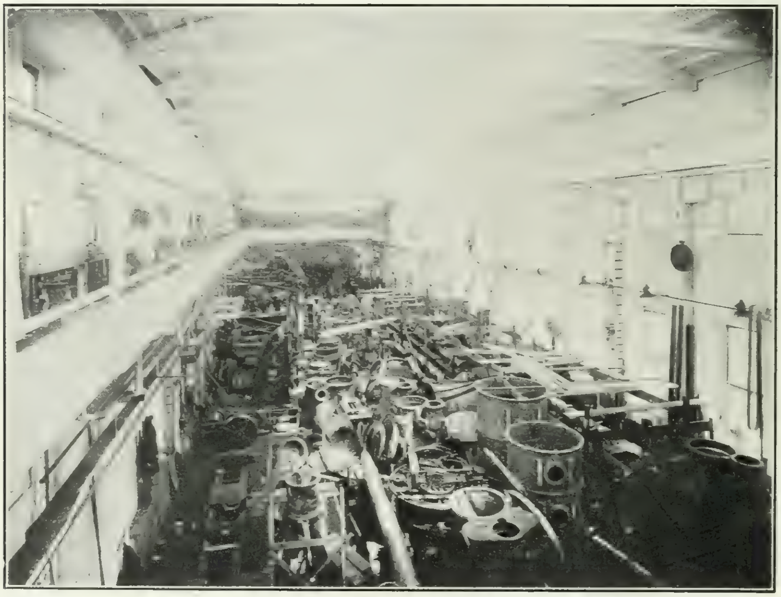
The Newport News yard is probably better equipped than any other single plant in the world with steam- and electrically-operated ship-building cantilever cranes. All of the five large cranes of this type have the same plan of operation. Between each pair of ship-ways is a high trestle, upon a track on top of which is mounted one of the cranes. The horizontal boom of the crane is high enough above the ship-ways to pass over the highest point of the ships being built, while the arms of the cantilever project over the full width of the ship on each side of the trestle. On the cantilever of the crane is a trolley and hoist block, whereby the load can be hoisted from the ground and traversed from one end of the cantilever to the other. Thus, inasmuch as the crane travels up and down the trestle, the entire length and width of the two ships are covered and materials may be handled and delivered to any part of the ships under construction. Each of the more recently constructed cranes has a tramway 187 feet in length, and the working loads range from 4½ tons 89 feet from the center to 14 tons 55 feet from the center. The trolley will attain any speed desired on the tramway, while the crane is capable of traveling along the track at a speed of 750 feet per minute.

The plant of the William Cramp & Sons' Ship- and Engine-Building Company at Philadelphia, as the pioneer among the larger American ship-yards and the scene of the construction of many of the more important vessels of the "new navy," is easily one of the best known institutions of the kind on the continent. The extensive improvement and enlargement of the Cramp yard, which has been in progress for a year or two and which will require fully a year more for its completion will, however, change the plant almost beyond recognition. Some idea of the magnitude of this undertaking may be gained from the fact that whereas the old yard contained but 30 acres, the new will embrace an area of about 50. Two new slips 700 feet long have recently been completed and are now occupied by the largest hulls ever built in the United States.



THE MASSACHUSETTS, INDIANA, AND PIRATE ON THE STOCKS AT THE CRAMP COMPANY'S YARD.

At present almost all the in-door work at the Cramp yard is performed in one range of buildings, 1,164 feet in length. In this are included the joiner, pattern, machine, and erecting shops, the ship-shed, two mold lofts, and the bending shed. The new buildings now under way or recently completed include a machine shop, blacksmith shop, structures for punches, shears, and rolls, and a power-house from which will be supplied electrical current for both power and lighting purposes. It is the plan eventually to displace with electric motors almost all the engines for the operation of individual machines throughout the yard. There is an apportionment of space in the new power-house for various kinds of pumps, including those for fire protection and for the air compressors supplying the equipment of pneumatic appliances. The equipment of pneumatic appliances at the Cramp yard is very similar to that at the other first-class American yards. Power for the hammers and drills is furnished by a 2½-inch main. The usual practice at the large yards is to employ the single-squeeze pneumatic riveter for work in the frame sheds on bulkheads and reverse frames, while for general work preference is usually given to a see-saw arrangement consisting of a beam supporting the riveter at one end with a counter-balance at the other.


INTERIOR OF THE MACHINE SHOP, WILLIAM CRAMP & SONS' SHIP AND ENGINE-BUILDING CO., PHILADELPHIA, PA.

The new machine shop of the Cramp Company is 335 by 143 feet, of steel-skeleton framework construction. The floor load in the second story is 400 pounds per square foot, while the third floor is designed for a load of 350 pounds per square foot. The structure has a main central traveling-crane runway, served by two 50-ton electric cranes, with a span of about 57 feet center to center of supporting girders. On either side of the main central portion are machine-shop galleries, having a width of 42 feet. The floor space in the lower story of both wings is served by electric cranes from 10 to 30 tons capacity.

BOILERS AND CONDENSERS IN THE CRAMP COMPANY'S YARDS.

In considering the crane and derrick equipment of the Cramp yard, the foremost place must be given to the Atlas, the largest and most powerful floating derrick in the world. The pontoon of the structure is 73 feet in length, 62 feet in width, and 13 feet in depth. When carrying the maximum load of 125 tons at the boom end, and with water ballast aft sufficient to bring her to an even keel, the Atlas has a freeboard of 16 inches and a displacement of 1,563 tons. The cone has a diameter of 40 feet at the base; the length of boom from the axis is 58½ feet, and the boom swings 36 feet clear of the pontoon. The height from deck to masthead is 116 feet and from deck to boom 65 feet. The maximum hoisting height is 50 feet. The pontoon is of iron, while the boom and mast and all lifting and traversing gear are of steel. The yard is provided with three electric traveling cantilever cranes of the same type described in connection with the mention of the Newport News plant. The cantilevers range from 140 to 200 feet in length. All three are mounted on steel trestles of special design.

The largest ship-building plant on the Pacific coast is that of the Union Iron Works, and it is in many respects the embodiment of the best and most progressive ideas. The yard embraces, all told, about 30 acres, and includes 7 building slips, the arrangement of which in so far as the handling of material is concerned is admirable. Vessels are constructed at this yard under framework sheds of the character of those in use at the plant of Swan & Hunter and other British yards. All of the sheds at the San Francisco yard are of wood, three having a length of 300 feet each and the fourth a length of 468 feet, with crane at each end of 25 foot swing, making the total length of crane-covered space 500 feet. The width is 85 feet and the height varies from 72 to 84 feet. Electric cranes are provided at both ends of each shed. These conveyors travel fore-and-aft at the rate of 180 feet per minute and crosswise at a speed of 90 feet per minute. The lifting capacity is five tons and the speed 90 feet per minute. The Union works is also provided with a hydraulic lifting dock of exceptional interest. The keel blocks are carried on a platform 435 feet in length and 62 feet in breadth, and the lifting operation is performed by hydraulic rams on each side. The dock is capable of lifting 6,000 tons to a height of 32 feet.

IN THE YARDS OF THE WILLIAM CRAMP & SONS' SHIP AND ENGINE-BUILDING CO., PHILADELPHIA, PA.

WATER FRONT OF THE UNION IRON WORKS, SAN FRANCISCO, CAL.

The plant has also a hydraulic bending machine for bending plates up to 4 inches in thickness. The machine bends the plate cold, to any shape—conical, cylindrical, or spiral, to suit any part of the ship. This is probably peculiar to this yard. It has also a boring mill, for turning off turrets and fitting the turret rings to the ship, which turns up to 30 feet in diameter. It is believed that this yard is the only one in America making the turret rings (26 feet in diameter), in a single piece.

The plant of the New York Ship-Building Co., at Camden, N. J., upon the installation of which work was commenced in the summer of 1899, will cost when completed more than $6,000,000 and will be entitled to rank with any of the yards previously mentioned. The company owns a tract of 120 acres and the yard has a frontage of 3,500 feet on the Delaware River, there being a depth of 40 feet of water along the entire front at low tide. Perhaps the best idea of the magnitude of the yard may be conveyed by the statement that the six largest buildings will be respectively of the following dimensions: 92 by 180 feet, 156 by 557 feet, 184 by 557 feet, 412 by 940 feet, 50 by 100 feet, and 115 by 130 feet. There are, in addition, a number of wooden buildings. The New

York company will build the major part of its vessels under framework shelters similar to those at the yard of the Union Iron Works at San Francisco and thus, for the time being at least, no traveling cantilever cranes will be introduced.

YARDS OF THE MARYLAND STEEL COMPANY, SPARROW'S POINT, MARYLAND.

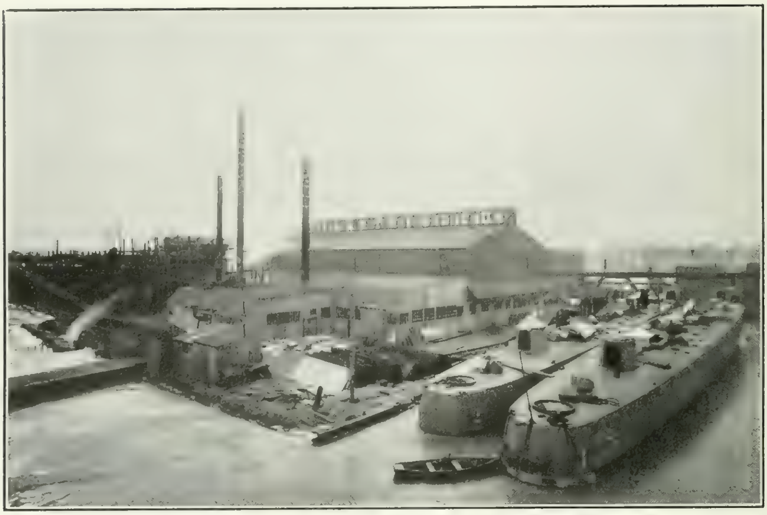
Among the other new ship-building plants of magnitude now in process of formation is the yard of the Eastern Ship-Building Co., on the Thames River at New London, Conn. Connected with the new institution are several ship-builders of experience, including Messrs. Charles R. Hanscom and William A. Fairburn, formerly superintendent and naval architect, respectively, of the Bath Iron Works, of Bath, Me. Vessels of the largest size, merchant and war, will be built. Indeed, the company already holds the contract for the construction of two vessels for President James J. Hill of the Great Northern Railway, which will be the largest in the world. These vessels, which will cost $5,000,000, are to be built for the Pacific trade. They will be 650 feet in length by 73 feet beam, with seven decks, and it is asserted that they will have a greater tonnage than any vessels heretofore built or projected. Other important new ship-yards are in contemplation, including a $1,000,000 plant at New Orleans and an extensive yard near New York City, but as yet they can none of them be said to have passed the preliminary stage.

A couple of ship-building plants which, while possibly in the secondary class at present, may be expected ere long to take rank with the most prominent firms, are found in the yards of the William R. Trigg Company at Richmond, Va., and the marine department of the Maryland Steel Co., at Sparrow's Point, Md. Both may rightfully be classed as new plants. The yard of the Maryland company was, it is true, originally established years ago; but not only had it been out of operation for a long period prior to the autumn of 1898, but the management has, in the interval which has elapsed since the yard was reopened, so modernized the equipment as to give the plant the semblance of an entirely new institution.

The Sparrow's Point yard employs regularly about 800 men, and some important work is under way there, including the steel floating dry-dock under construction for the United States government—the largest in the world. The equipment of the yard includes a complete outfit of pneumatic tools and some machine tools of very fair capacity. Probably the most interesting feature of the equipment, however, because the most unique, is a type of locomotive derrick, designed and built at the Maryland company's works. There are a number of these derricks in the yard. The idea of the apparatus is to raise the ship plates from the ground, instead of lowering them from above as is done at the Newport News and other yards where traveling cantilevers propelled by electricity or steam are employed. In the principle of operation on standard-gauge track, the derrick corresponds to the regulation type of locomotive crane, utilized in all ship-yards for the handling of material; but instead of being mounted on the ordinary type of flat car, the apparatus in this case is operated from the top of a steel derrick which permits of 10 tons or even more being raised to a height of 60 or 70 feet. The arrangement of the Sparrow's Point yard is such as to facilitate economy of time. The machine, boiler, and joiner shops form one group of buildings, and the bending and ship-fitting sheds and other similar departments another.

MARINE DEPARTMENT, MARYLAND STEEL CO., AT SPARROW'S POINT, MARYLAND.
Showing the novel type of derricks used at these yards.

The circumstances surrounding the establishment of the yard of



PLANT OF THE WILLIAM TRIGG COMPANY, RICHMOND, VA.

the William R. Trigg Company, of Richmond, Va., illustrate what may be accomplished when the proverbial American energy is carried into ship-building. In the summer of 1898 Mr. Wm. R. Trigg submitted bids for the construction of several torpedo boats and destroyers. At that time Mr. Trigg held an option upon the plant of the Virginia Machine Company, and upon several acres of property situated upon the Richmond docks.

In the face of some opposition, based upon the fact that he had no established organization, he was awarded the contract for three torpedo boats and two torpedo-boat destroyers. Within sixty days from the date of the award the Trigg Company had been organized and had in operation a plant employing 200 men, and at this time over 800 men are employed. The company has been so successful that it has purchased 25 acres of land lying between the dock and the river, and has begun the erection of a dozen large buildings. The machinery equipment is in accordance with the latest modern practice. The three torpedo boats have been launched and the company now has contracts for the cruiser Galveston, of the Denver class, two revenue cutters, two steamboats, and is rebuilding the sub-marine torpedo boat Plunger. The Trigg yard has at present but one limitation—the draught of water in the James River. When the channel is dredged to 25 or 28 feet, there is no reason why the Trigg company should not build the heaviest ships used by the Government.

(To be continued.)

THE COMMERCIAL ORGANIZATION OF THE MACHINE SHOP.

By Hugo Diemer.

II.—THE PRODUCTION DEPARTMENT—BILLS OF MATERIAL.

IN many establishments there is no one outside of the drafting department who has at hand any data showing the distinct separate items required to make up a complete machine. In order to facilitate prompt manufacture, it is important that there be some person whose duty it is to see that, without overstocking, sufficient material is on hand to complete all orders with the least possible delay. This person must be so familiar with methods of manufacture that, with the guidance of the data furnished him by the drafting department as hereafter mentioned, he will be able to order all material which needs to be bought from outside sources. He must also be competent to provide a necessary stock of such finished parts as must be carried in the stock-room, besides providing a sufficiency of tools and patterns. He must be able to judge when pressure of orders requires a duplication of tools and patterns, without going to unnecessary expense in this regard. All orders for such extra tools and patterns, of course, pass through the general superintendent's hands for approval before being issued to the shop.

As soon as the drafting department has received its shop order, it prepares three lists for the bill of material clerk, viz.:

(1) The Drawing List.
(2) The Pattern List.
(3) The Tool List.

The drawing list gives the numbers of all drawings required in the manufacture of the machine. The pattern list gives the numbers of all patterns, together with corresponding drawing numbers, and the tool list gives a similar list of tool numbers and corresponding drawing numbers, these lists covering all patterns and tools required in the manufacture of the machine.

If the machine is a standard one, which has already been built, the preparation of the bill of material and the following up of material, patterns, and tools is a comparatively simple matter. But it is a less

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Professor Diemer's articles began in the issue of THE ENGINEERING MAGAZINE for June, 1900. The first of the series was "The Systematized Classification of Shop Orders."

easy task to push through a new machine in which part, or perhaps all, of the drawings and patterns and many tools will be new ones.

A good plan is to mark with a rubber stamp "Complete," those drawing-, tool-, and pattern-lists to which there will be no further additions. The reason for this is that it is frequently desirable that the bill-of-material clerk should receive the lists before they are entirely complete, so that he may begin ordering material. The lists thus sent in will, of course, contain only such drawings as are certain to be used, nothing doubtful being inserted. The bill-of-material clerk returns these incomplete lists to the drafting room as soon as he has ordered as much material as possible, retaining the lists permanently only when they are marked "complete." It is, of course, far preferable not to begin work until all the data are complete, because there is always a possibility of changes being necessitated as the machine develops. The circumstances of each particular order will determine whether or not it will be necessary to send in incomplete lists to the bill-of-material clerk.

The material clerk needs to be provided with a set of all drawings, so that he may have access to them at all times without interfering with the work of the drafting or designing departments. It is apparent that it is very advantageous, from the standpoint of convenience and rapidity to the clerical force, to have drawings of a uniform size, sufficiently small to be handled and filed with ease. It is always desirable to make drawings in this way where it will not sacrifice shop accuracy or economy. It is easier than one would first suppose, however, for a shop to adapt itself to drawings of small size. A prominent electrical factory does more accurate work at the present time from drawings uniformly 10 inches by 14 inches than was done in the same shop five years ago from full-size drawings. Small drawings of a uniform size possess the advantage that they may be easily bound with fasteners into sets of one hundred and conveniently kept in a pigeonhole case for reference.

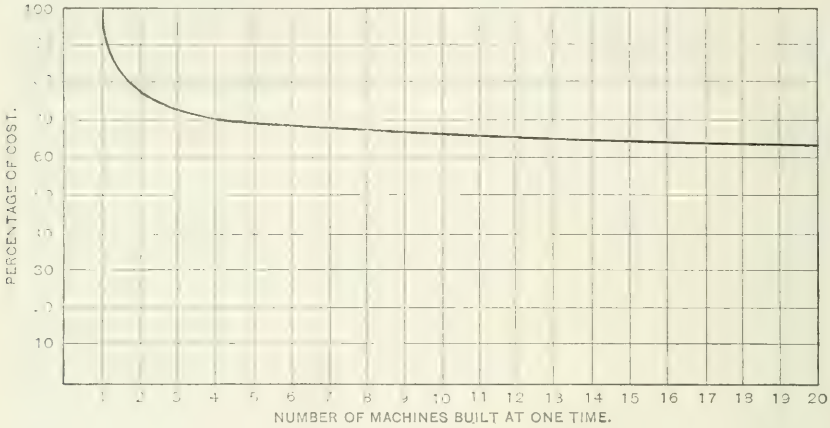
When the bill-of-material clerk receives his lists from the drafting-room he begins at once to make out his bills of material. In some factories these material lists are called "specification sheets," but a bill of material is not a specification, hence I believe the term "bill of material" or "material list" is preferable.

Where but one general store-room is used in a shop, a single bill of material will suffice. Where there are distinct stock-rooms for different sections or departments of a factory, and a machine needs to pass through several such departments, it is needless for any one department to have a complete bill of material, it being sufficient to supply each department with a list of all material which it needs for the completion of its work on the order.

The bill of material can be made extremely useful for three distinct purposes: First, it serves as a record of the time of ordering and receiving material needed; second, it may be used in drawing material from the stock-room; third, it may be used as a record of material actually drawn as compared with material specified, thus affording reliable data for the cost department.

The normal condition of a successful shop is that it is full of work for some time ahead. Orders for standard machines are coming in in a constant stream. In certain lines of manufacture the variety of machines demanded prohibits the extensive issuing of stock orders. In such cases, if the shop is full of work, it is well to refrain from issuing formal orders when it is certain that no action on them can be taken in the shop for some days to come. It is best to wait some days and then be able to issue one shop order covering two, three, or four machines of a kind, instead of having separate orders for like machines stringing along singly. Where the latter plan is followed, the question which machine is which is almost certain to cause confusion and loss of time. Men charging up their labor on time tickets, or drawing material from store-rooms, will have to spend more time in looking up the separate order numbers than if all the machines were built on one shop order. If a number of similar machines are simultaneously built on separate orders, the cost department will frequently find a wide variation in cost of labor, one machine being absurdly low and another absurdly high; nothing remains but to "lump" them. This means going over all the labor on each machine separately, adding all together, averaging, and redistributing, thus making a "doctored" record.

A comparison of cost records covering several years has convinced me of a marked saving in building two machines of a kind at once, over their cost if built singly. Where a duplicate machine is at all likely to be available stock, it is far best to make one. The saving in cost of labor does not increase directly with the number of machines built at one time, however. The accompanying curve, which will be found in the diagram on the following page, indicates the results of comparisons of costs of labor on several hundred electrical generators and motors. The abscissæ represent the number of machines built simultaneously: the ordinates, the relative cost. The cost of one machine built by itself was taken as 100 per cent. Then the percentage of this cost was taken when two or more machines of a kind were built. The reduction to percentage made the curve a general one, applicable to all sizes of machines. It will be noted that there is a marked drop when two machines are built at once, but that after that the fall is very gradual.



CURVE SHOWING REDUCTION IN COST BY BUILDING SEVERAL MACHINES AT ONE TIME.

In addition to the internal economy, there will be a saving of labor to the clerical force by simultaneous manufacture or "bunching" of several shipping orders into one shop order. In addition to this, the issuing of but one bill of material will effect a saving of drayage, freight, and handling on castings and other items which would string along separately if separate bills of material were issued for each shipping order.

Every piece should have a concrete name by which it will be known, as well as its pattern number. This naming will be found useful, not only for prompt identification of parts in the shop and stockroom, but also in making up price lists of repair parts.

In order to illustrate the uses of the bill of material I append extracts from a bill of material for an engine lathe, also part of a bill covering the work on the armature of an electrical generator or motor in the winding and insulating department.

The first column, headed "Material," states whether the piece is made of cast iron, cast steel, wrought iron, malleable iron, tool steel, cast copper, cast brass, brass rod, copper rod, etc., suitable abbreviations being used, such as c. i. for cast iron, etc. At one time I sought to simplify matters by printing the names of certain pieces that were to be made of cast iron in a certain kind of type, and using different

BILL OF MATERIAL

SECTION............................

Shop Order No............................ *Date*............................

............*Machines.* *Type*............................

To be completed............................

Remarks............................

WINDING AND INSULATING DEPARTMENT.

ARMATURE.	Material	Size or Pattern No	Drawing No.	Quantity Required.	Date Ordered.	Date Received.	Material Drawn from Store Room.	Total Weight.	Cost, Material.	Cost. Labor.
Copper Wire............										
" "										
" "										
Copper Strip										
" "										
Mica..................										
Thin Press Paper										
Thick Press Paper......										
Cardboard										
"										
Micanite Cloth..........										
Empire Cloth										
Stay Binding										
Tape										
Cord										
Duck										
Solder										
Linen..................										
Twine										
Cotton Tubing										
Wood Strips............										
Brass Wire.............										
Soldering Compound...										

BILL OF MATERIAL.

SECTION....................................

Shop Order No.. *Date*...

............*Machines.* *Type*...

To be completed...

Remarks...

	Material.	Size or Pattern No.	Drawing No.	Quantity Required.	Date Ordered.	Date Received.	Material Drawn from Store Room.	Total Weight.	Cost, Material.	Cost, Labor.
Bed										
Right-Hand Leg........										
Left-Hand Leg..... ...										
Lower Portion of Tail Stock										
Upper Portion of Tail Stock										
Tail-Stock Spindle......										
Hand Wheel for Tail Stock										
Tail-Stock Spindle Screw										
Lever for Clamping Tail-Stock Spindle										
Washer for Clamping Lever										
Bolt for Fastening Tail Stock to Bed										
Nut for Same..........										
Drifting Screw for Tail Stock										
Tail-Stock Sleeve......										
Head-Stock Casting ...										
Head-Stock Spindle ...										

kinds of type for brass and copper pieces, and so on. But it soon developed that pieces known by the same name might at various times and under varying conditions be made of different materials, sometimes of cast iron, sometimes of malleable iron, and sometimes of brass, so the idea of separate type was dropped, the column headed "Material" being used for this purpose. The second column is headed "Size or Pattern Number." Where the piece is one cut out of rod metal, the size of the rod is given—such as ¾-inch round, or 1 inch by 1½ inch; if a casting, the pattern number is inserted. The next column is headed "Quantity Required." The next is headed "Drawing Number," and the following two columns "Date Ordered" and "Date Received," respectively. If the material is in stock, the words "in stock" are written across these two columns. It is the business of the bill-of-material clerk to keep in touch with the purchasing department, following up all castings and other special material which is noted in the "Date Ordered" column, but which has not yet been received. As soon as the bill of material is completed, the bill-of-material clerk goes to the stock-room and determines what material is in stock and what needs to be ordered. The marking or arrangement of such material as is in stock will be considered under the subject of "Stock-Room Management," as will also the use of the wide column entitled "Material Used." The next column is entitled "Weight." In this column is inserted the weight of all castings and other pieces whose price is figured by weight. In order that the material clerk may properly fill in these columns, headed "Date Received" and "Weight," it is evident that he should receive either the invoice with notation of date received, from the receiving department, or else a list of all goods received. The invoice itself can be made to answer the purposes of a list of material received by the store-room. A pencil list, however, made out with a stub and carbon copies, one set for the purchasing department and one set for the material clerk, has the advantage of being a complete consecutive record, and is easier to refer to than invoices are.

The bills of material may advantageously have holes punched in them so that they may be kept on a prong file, separate file boards being used for bills which are not complete, bills on which all material is in, and bills on which material is still to come in.

The position of bill-of-material clerk is one that can easily be filled by a young man from the drafting department. It is evident that he must be a man who can read drawings and who is familiar with the pieces constituting the machine.

THE SETTLEMENT OF THE MACHINISTS' STRIKE.

THE threatened trouble between employers and employees in the American metal trades, which at one time seemed likely to bring on an industrial war more disastrous than that which distressed the English engineering world in 1897, have reached a settlement that appears to have the elements of endurance and stability.

It is strong because it is based upon justice, fairness, and reason—upon principle, not merely upon expediency. The happy results of an honest and open-minded effort to arrive at a "mutual understanding of one another's views and of the approaches by which they have been reached," for which THE ENGINEERING MAGAZINE has been a constant and earnest advocate, are clearly apparent in the agreement which is given herewith in full, except in so far as it covers a special settlement of local labour troubles in Paterson.

And yet another most gratifying circumstance attending it is that it comes, instead of, and not as the result of, a long, bitter, and mutually exhausting struggle. The lessons of the industrial peace which England bought so dearly two and a half years ago have been studied by manufacturers and workmen; echoes of the agreement between the Employers' Federation of Engineering Associations and the Amalgamated Society of Engineers sound through the resolutions of settlement unanimously adopted by the National Metal Trades' Association and the International Association of Machinists. That this is attributable in large part to the growth of foreign trade there can be no doubt. Practice and experience are alike becoming international possessions.

While the New York settlement does not directly touch upon piece-work, minimum wage, or the handy man, it establishes a precedent of wise, temperate, and common-sense agreement which is the best and more certain assurance against future discord. Indeed, with these two great instances, English and American, of the adjustment of labour troubles by arbitration, and of the permanent establishment of organisations powerful enough to assure the fulfilment of their

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Preceding articles upon this topic in THE ENGINEERING MAGAZINE have been:

Labour Questions in England and America. Charles Buxton Going. May, 1900.
Manufacturers' Associations, Labour Organizations and Arbitration. H. W. Hoyt. May, 1900.
New Shop Methods a Corollary of Modern Machinery. Editorial. June, 1900.
Piece Work Not Essential to Best Results in the Machine Shop. James O'Connell. June, 1900.

agreement, wise and tolerant in their efforts to understand one another's attitude, and moved by reason and justice in framing their own demands, the whole industrial world has moved a long way toward a solution of the labour problem. The millenium is not yet—witness the outrages of the situation in St. Louis. The wisdom of the leaders may not always be recognised nor their agreements loyally observed by the rank and file. The labour union, in its present form, is not a very responsible organisation, and shows a tendency to profit by its intangibility too often to establish a very strong feeling of confidence.

The agreement is thus set forth:

"The resolutions as adopted were adopted in the order as here presented, and become binding upon all members of the National Metal Trades' Association and the International Association of Machinists. The official act of this joint conference establishes a precedent for national arbitration as called for under what is known as the Chicago Agreement of March 17th, accepted and signed by both parties March 31st. The hearing has been harmonious, and the decisions arrived at satisfactory alike to both parties.

*"The Board of Arbitrators representing the International Association of Machinists during this conference had by wire and telephone as an advisory board members of the local organizations throughout the United States. The arbitrators on behalf of the National Metal Trades' Association had with them as an advisory board the Administrative Council and other members of their Association from various parts of the United States. During the entire session on recess or adjournment the respective boards of the conference committee met with the boards of their respective organizations for consultation.

*"It should be stated that prior to any matters being taken up for arbitration, the strikes existing in Paterson, N. J., and Cleveland, Ohio, were officially declared off by the International Association of Machinists, represented by their Board of Arbitration in shops that were members of the National Metal Trades' Association, and the members of the National Metal Trades' Association in Cleveland and Paterson were notified by their members on the board of arbitrators that they on their part must comply strictly with the spirit and letter of the Chicago agreement. This being accomplished the arbitrators commenced their session, there being no strikes or lock-outs in any shops in the United States except Cleveland and Paterson. The first two resolutions adopted fully explain the action taken by the arbitrators in connection with Paterson and Cleveland.

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* See explanatory note on page 522.

"*Whereas,* conflict between capital and labor has been disastrous alike to each, the International Association of Machinists and the National Metal Trades' Association, appreciating the importance of adopting some measure that would provide against strikes and lockouts in the future, met in joint conference for the purpose of adopting such measures as would be alike just to the employee and the employer. This conference, meeting in New York May 10, was in continuous session until May 19, having formulated a code by a series of resolutions, which for the first time established the value of national arbitration, and by their act has, it is believed, made history which will benefit all other like organizations.

*"*Resolved*: That the strikes be declared off in the factories of the members of the National Metal Trades' Association in the cities of Cleveland and Paterson, the National Metal Trades' Association members of this Board to wire the members of their association in these two cities to meet a committee, from each shop, of their former employees to arrange for the return of as many men as their present necessities require; and that subsequent requirements of men shall be filled from their former employees whom they may not be able to reinstate at the present time.

*"The intent of this last clause is, that if, within the next six months, former employees make application for re-instatement they shall be re-instated, provided there are vacancies for them.

*"Where strikes exist in these cities in firms other than the members of the National Metal Trades' Association, who will agree to the settlement herein entered into, after the same has been adjusted by this joint body, such strikes shall be declared off also.

"*Whereas*, doubts have been expressed by members of this Board, representing both parties to this conference, as to the ability of their respective organizations to control their members;

"*Now, therefore,* be it resolved that the members of this board pledge themselves each to the other that in case of the refusal of any member of the respective organizations represented to observe and carry out in an honorable manner the findings and decisions of this board, in regard to strikes and lockouts, based upon a fair, just and liberal interpretation as to what is known as the Chicago agreement, we will report such member or members to our respective organizations for discipline, suspension or expulsion, as the merits of the case may justify.

"Machinist.—A machinist is classified as a competent general workman, competent floor hand, competent lathe hand, competent vise hand, competent planer hand, competent shaper hand, competent milling-machine hand, competent slotting-machine hand, competent die sinker, competent boring-mill hand, competent tool-maker, and competent linotype hand. To be considered a competent hand in either class he shall be able to take any piece of work pertaining to his class, with the drawings or blue prints, and prosecute the work to successful completion within a reasonable time. He shall also have served a regular apprenticeship or have worked at the trade four years.

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* See explanatory note on page 522.

"It is understood that the question of competency is to be determined by the employers. Since the employers are responsible for the work turned out by their workmen, they shall, therefore, have full discretion to designate the men they consider competent to perform the work, and to determine the conditions under which it shall be prosecuted.

"This last paragraph does not, in any way, abridge or destroy the right of appeal from any apparent or alleged unjust decision rendered by an employer of labor, or his representative, in conformity with the powers vested in him by this paragraph.

"Overtime.—All overtime up to 10 o'clock P. M., shall be paid for at the rate of not less than time and one-quarter time, and all overtime from 10 P. M., until 12 midnight shall be paid for at a rate of time and one-half time, and that after 12 o'clock and legal holidays and Sundays shall be paid for at a rate of not less than double time.

"In cases of emergencies, where shop machinery breaks or runs down, and it is absolutely necessary to repair the same so that the factory can run on Monday, this time shall be paid for at a rate of time and one-half. The repairs above referred to apply only to machinery of the employer.

"The foregoing rates not to interfere in any way with existing conditions; that is, where a higher rate than the above is paid now, no reduction will take place.

"Such rates for overtime shall not apply to men regularly employed on night gangs.

"Apprentices.—There may be one apprentice for the shop, and in addition not more than one apprentice to every five machinists. It is understood that in shops where the ratio is more than the above, that no change shall take place until the ratio has reduced itself to the proper number, by lapse or by the expiration of existing contracts.

* "Employment and Hours.—No discrimination shall be made

against union men, and every workman shall be free to belong to a trade union, should he see fit. Every employer shall be free to employ any man, whether he belong or not to a trade union. Every workman who elects to work in a shop will be required to work peaceably and harmoniously with all fellow employees, whether he or they belong to a trade union or not. He shall also be free to leave such employment, but no collective action shall be taken until any matter in dispute has been dealt with under the provisions for avoiding disputes as per the Chicago agreement, dated March 17th, 1900, signed March 31st, 1900. The National Metal Trades' Association does not advise its members to object to union workmen or give preference to non-union workmen.

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* See explanatory note on page 522.

"Fifty-seven hours shall constitute a week's work from and after six months from the date of the final adoption of a joint agreement, and fifty-four hours shall constitute a week's work from and after twelve months from the date of the final adoption of a joint agreement. The hours to be divided as will best suit the convenience of the employer.

*"In consideration of this concession in working hours, the International Association of Machinists will place no restrictions upon the management or production of the shop and will give a fair day's work for a fair day's wage.

"*Note.*—This not to interfere in any way with shops where a less number of hours per week is already in operation."

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* NOTE.—The paragraphs marked with an asterisk, though an integral part of the agreement, are omitted from a blank form of "Agreement" which, as this article is written, is being distributed widely, apparently by someone undertaking to act for the machinists. Apparently, also, it is designed for adoption as a shop agreement, as it has spaces for signature by the "firm," and by the local representative of the "I. A. of M." It bears the prefatory heading "Copy of Resolutions Passed and Adopted by the Arbitration Board of the National Metal Trades' Association and the International Association of Machinists, at Murray Hill Hotel, New York, during its Sitting, May 10 to May 18, 1900, the Sitting Being Continuous during this Period of Time." We have, however, official assurance from the International Association of Machinists that no copy of the agreement has been published from their office "other than official circular No. 10," "which is not intended in any way as a basis of agreement between individual firms and their employees." It is, as the copy in our hands clearly shows, merely a general summary of the gains effected by the settlement, as estimated by the machinists. These are, briefly, five: national recognition of their organization; limitation of apprentices; definition of a machinist; shortening of the working day; and adjustment of overtime and the rates to be paid for it.

UTILIZING THE WASTE HEAT FROM THE GAS ENGINE.

By Alton D. Adams.

EXHAUST from steam engines is now generally used for heating purposes, with good results and a great saving of otherwise wasted heat. The rapidly-increasing applications of gas engines render means for the use of their waste heat important, but little seems to have been done thus far toward effecting this end. Lack of greater progress in the utilization of the heat from gas engines is probably due in part to the forms in which this heat is available. Exhaust steam contains substantially all of the heat that can be recovered from steam engines, but at the gas engine heat appears in large amounts under two forms—the jacket water and the exhaust gases. It is a comparatively simple matter to apply exhaust steam in a heating system, but more of a problem to save the heat of the jacket water and gases for useful purposes. If buildings are to be heated by gas engines, it is quite evident at the start that heat distribution can best be effected by air, steam, or hot water in one of the usual ways. Whatever is done as to the distribution of heat must not seriously interfere with the operation or efficiency of the engines, so the effects on exhaust gases and jacket water should be carefully considered. One of the first and most important points to be decided is the amount of heat per hour, or the square feet of radiating surface, or the space that may be heated from a gas engine of given capacity, when working at full load.

The efficiency of gas engines—that is, the ratio of delivered work to the fuel energy of the gas consumed—varies with their size and construction. Inspection of results from a large number of tests, however, seems to indicate that the efficiency and losses, based on the total calorific power of consumed gas, may be fairly assumed as follows for engines of moderate capacity: Efficiency, that is the ratio of delivered brake horse-power hours to the heat energy of the gas consumed, 18 per cent. Losses by conduction and radiation of heat from the engine frame, 5 per cent. Heat escaping in the exhaust gases, 37 per cent.,

One of the most striking manifestations of modern economy is the saving of by-products. In many departments it has revolutionized industrial practice. The choice of means or methods is often determined by the recoverable values in what was formerly waste. This tendency is as strongly manifest in the power-house as it is in the gas works, and Mr. Adams will be followed with interest in his view of the possible economies of the newer forms of motor, and of the practical means for making these economies available.—THE EDITORS.

and in the jacket water 40 per cent. As one horse-power hour of work is the equivalent of 2,545 heat units, the assumed efficiency of 18 per cent. corresponds to an hourly development of 2,545 ÷ .18 = 14,139 heat units at the engine for each horse-power hour of output. Of this amount of heat, 37 per cent., or 5,231 heat units, escape in the exhaust gases and 40 per cent., 5,655 heat units, in the jacket water. The sum of these losses, 10,886 heat units, represents the total heat added to the exhaust gases and jacket water, per delivered horse-power hour, but it by no means follows that all of this heat can be recovered to warm buildings. As about one-half of the heat given off by the engine is in the jacket water, it seems at once desirable to add to this water as much as possible of the heat from exhaust gases, so as to combine the two supplies. Such a combination of heat seems practicable from the fact that the temperature of the jacket water is usually much below that of the exhaust gases. The requirements of lubrication hold the temperature of the cylinder, and consequently of the jacket water, at about their present maximum figures, though engine efficiency would be improved by higher values. It is, therefore, desirable to take jacket water at the temperatures now common, and add thereto as much as is practicable of the heat in the exhaust. About 150 degrees Fahrenheit seems to be the present maximum temperature advisable for jacket water on leaving the cylinder. To raise water from 32 degrees to 150 degrees Fahrenheit requires 118 heat units per pound, while 1,028 heat units must be added to each pound of water at 150 degrees, to change it to steam at atmospheric pressure. It therefore seems that only about one-tenth of the jacket water, from a gas engine, can be turned to steam by the entire heat in its exhaust gases, even if all of it can be extracted. Any plan that involved steam heat alone would consequently make use of little more than one-half of the total available heat from the engine. In ordinary cases it hardly seems desirable to make use of both steam and hot-water heating systems, so that an arrangement by which the temperature of the jacket water is raised by the exhaust gases gives the greatest promise of economy.

In a hot-water heating system, operated from a gas engine, the jacket water, after leaving the engine, should pass through pipes that are subject to the action of the exhaust gases. Leaving the gas-heated pipes, the hot-water supply should go to the radiators or other heating surface, and thence back to the water jacket on the engine cylinder. The amount of heat that can be extracted from the exhaust gases by the jacket water, with suitably proportioned heating surface, obviously depends to a large extent on their relative temperatures. There is much uncertainty about the temperature of gas-engine exhaust, unless all of the conditions of operation are known, but 1,050 degrees Fahrenheit seems to be a conservative estimate for an average case. Experience with economizers indicates that gases of combustion may be reduced in temperature to within 150 degrees of that of the water in the heated tubes at the outgoing end, without too much extension of the heating surfaces. Such a temperature should be selected for the water that leaves the gas-heated coils for the radiating surface, that it will reach the water jacket at a certain point below 150 degrees in temperature. The temperature of water on entering the cylinder jacket should be such, at the maximum rate of flow through the system, that it will be 150 degrees on leaving the jacket. If the exhaust gases are lowered from 1,050 degrees to 350 degrees temperature they give up approximately two-thirds of their heat. As the total heat escaping in the exhaust was taken at 37 per cent. of the calorific power of the gas consumed in the engine, about two-thirds of this, or 24 per cent. of the heat of gas combustion, may be added to the jacket water under the conditions named. With 40 per cent. of the heat from gas combustion in the jacket water before it comes under the action of the exhaust, the contained heat of the water is raised to $40 + 24 = 64$ per cent. of the total amount developed. Of the heat added to the jacket water by the gas engine, the cylinder supplies $40 \div .64 = 62$ per cent. and the exhaust gases 38 per cent. It will now be evident that the difference in temperature of the jacket or circulating water, from the time it reaches the cylinder until it leaves the gas-heated coils, may be varied through considerable limits, according to the design of the heating system. Thus, if the water pipes and radiating surface are so proportioned that the temperature of the circulating water falls 100 degrees, while passing through them, the temperature at the exit from the cylinder jacket being 150 degrees, the water will enter the jacket at $150 - 62 = 88$ degrees and leave the gas-heated coils at $150 + 38 = 188$ degrees, nearly. This result is due to the fact that the amount of heat required to raise one pound of water one degree in temperature at any point between the temperature limits named, corresponds very nearly to the true heat unit. If the range of temperature drop in the circulating water between the pipes to the radiating surface and those that return water to the cylinder jacket is only 40 degrees, then the rise of temperature in the water jacket, under the conditions named, is $40 \times .62 = 25$ degrees and the rise in the gas-heated coil 15 degrees. In this last case the circulating water enters the cylinder jacket at $150 - 25 = 125$ degrees and leaves the gas-heated coils at $150 + 15 = 165$

degrees. The objection to a large drop in the temperature of circulating water is the resulting low average temperature of the radiating surface and the increased amount necessary for a given work.

Allow each square foot of first-class, direct-radiating surface to dissipate two heat units per hour, for each degree difference in temperature between the water or radiating surface and the air, and a drop of forty degrees in the temperature of the circulating water in the radiator. This gives the radiator an average temperature of (125 + 165) ÷ 2 = 145 degrees, and allowing a room temperature of 70 degrees, each square foot of radiating surface dissipates (145 — 70)2 = 150 heat units per hour. In a regular hot-water heating system, designed, as is often the case, for a drop of temperature in the radiators from 210 to 190 degrees, the average temperature of the radiator is (210 + 190) ÷ 2 = 200 degrees, and the heat from each square foot per hour is (200 — 70) × 2 = 260 units. This last result is 260 ÷ 150 = 1.73 times as great as that obtained per square foot for radiators supplied from the gas engine. It is evident that the average temperature of water heated from a gas engine can be raised but little above that found, if all of the heat in the jacket water is to be utilized. Thus, if the drop of temperature of the circulating water from the gas engine is reduced to 20 degrees, the rise of temperature in the water jacket is 20 × .62 = 12.4 degrees, and the temperature of the entering water 150 — 12.4 = 137.6 degrees. The water, after entering the coils that are heated by the exhaust gases, is now raised in temperature only 20 — 12.4 = 7.6 degrees, making its maximum temperature 150 + 7.6 = 157.6 degrees and its average (137.6 + 157.6) ÷ 2 = 147.6 degrees, or only 2.6 degrees higher than when a drop of 40 degrees was permitted. If a larger variation of temperature in the circulating water exists, the average temperature is still lower. A result of the comparatively low temperature of water heated by gas engines is that about 1.73 times as much radiating surface must be used to dissipate heat at a given rate as is the case with the best independent hot-water systems. The cost of additional radiating surface is obviously a small matter compared with the great saving in heat to be made by the utilization of jacket water and exhaust from gas engines. As is well known, higher cylinder temperature, if satisfactory lubrication can be maintained, contributes to an increase of gas-engine efficiency. Such an increase of jacket-water temperature as would permit exhaust gases to raise this water to 210 degrees would therefore add to engine economy and cut down the radiating surface necessary to utilize the waste heat of gas engines. On the assumption that 14,139 heat units are developed at the gas engine for each brake horse power delivered, it was found that about 5,655 of these heat units pass into the jacket water. Practically all of this heat is available in a hot-water heating system, save the small amount necessary to raise the circulating water to the temperature of the building heated or to the temperature at which the water flows from the heating coils. Of the 5,231 heat units that escape in the exhaust gas, for each delivered horse-power hour, it was found that 66 per cent., or 3,452 heat units, representing 24 per cent. of the total amount developed, can be added to the jacket water after it leaves the cylinder. The total heat available for general purposes from a gas engine, under the stated conditions is therefore about 5,655 + 3,452 = 9,107 heat units per delivered horse-power hour. It was shown that one square foot of good radiating surface, when supplied with hot water from a gas engine, the drop in temperature at the radiator being 40 degrees, dissipates 150 heat units per hour, in an atmosphere at 70 degrees temperature. For each horse power delivered by a gas engine, about 9,107 ÷ 150 = 60 square feet of direct radiating surface should be supplied. So many factors enter to determine the heat necessary to warm buildings that no general and exact rule can be given, but allowing 10 heat units per hour for each cubic foot of space warmed, as a rough approximation, 9,107 ÷ 10 = 910 cubic feet may be heated for each horse power delivered by the engine.

The heat from gas engines may readily be applied to heating purposes in either of three ways—that is, by direct or indirect radiation and by the hot-air system. Pipes and heating surface are proportioned for either of these arrangements with heat from gas engines on the same principles as when a regular hot-water heater is used, except for the lower average temperature of heating surface and perhaps greater fall of temperature for the circulating water. Hot water from gas engines may be used for general heating, not only in private plants and buildings, but also for public supply through mains laid in the street. In this last case, or for any other where the distance or conditions prevent a suitable circulation of the water as a result of its fall in temperature, pumps may readily be used to maintain any rate of circulation desired. Power pumps driven by the gas engines will naturally be employed, and the consumption of gas required to operate them, in a well designed system, will represent only a small fraction of the heat energy recovered from the jacket water and the exhaust gases.

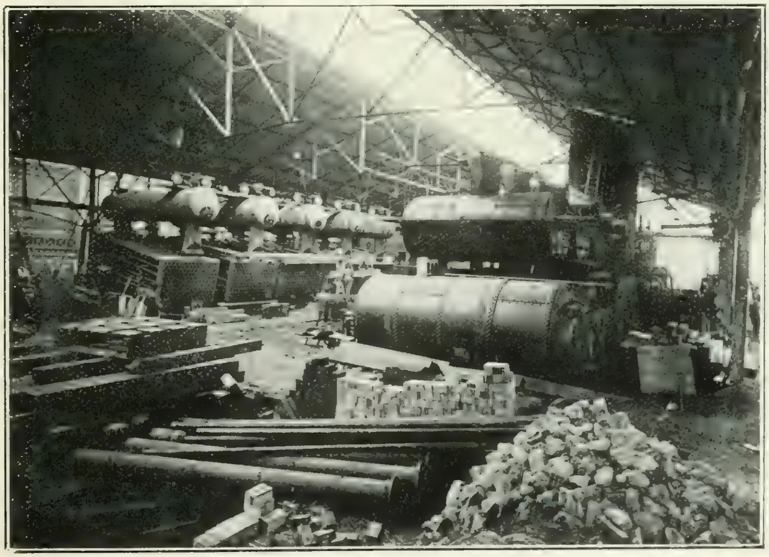
To consider the amount of coal that may be saved by the use of gas-engine exhaust, let the heat developed by the perfect combustion of one pound of coal be taken at 13,000 heat units. The boilers of heating systems in buildings may be expected to deliver to steam and hot water hardly more than one-half of the possible heat from coal, or 6,500 heat units per pound of coal burned. As each horse-power hour of operation by the gas engine was found to deliver 9,107 heat units to the circulating water, this amount of operation is equivalent in the heating system to 9,107 ÷ 6,500 = 1.4 pounds of coal burned under the steam or hot-water boiler. In the case of a 100 horse-power gas engine operating the equivalent of 3,000 hours at full load, or 300,000 horse-power hours, the heat imparted by it to circulating water would equal that from 300,000 × 1.4 = 420,000 pounds of coal. This coal, at $4 per short ton, has a value of $840, to say nothing of the labor necessary to operate the boiler and furnace where it is consumed. The arrangement of heating coils to receive the jacket water and add to it the heat of exhaust gases involves only a very moderate expense, and the care of this arrangement could be readily included with that of the gas engine.

So long as the gas-engine cylinder is kept within the desired temperature limits, the operation of the engine is obviously not affected by any use of the jacket water, so only the reaction of the heating system on the exhaust gases need be considered. In order to force the gas-engine exhaust through the bank of heating coils in which the jacket water circulates, a small back pressure must be set up in the engine cylinder. With properly-designed heating coils, this back pressure should be small and thus increase the gas consumption but little. Assuming a mean effective pressure of 50 pounds per square inch on the gas-engine piston, from the gas explosions, and 2 pounds per square inch back pressure, as a result of the heating coils, there would be a loss of 4 horse power on the 100-horse-power engine. In order to bring the engine up to 100 horse power, the gas consumption must be increased by the equivalent of 4(14,139) heat units per hour, by the assumption formerly made, or 81 cubic feet of gas, with 700 heat units per cubic foot. The value of this gas at one dollar per cubic foot is 8.1 cents, but the heat delivered by the gas engine to the hot-water system during one hour amounts to that from 1.4 × 100 = 140 pounds of coal under a heating boiler. At $4 per ton the value of this coal is (140 × $4 ÷ 2,000 = 28 cents, or three and one-half times that of the gas. With gas for gas engines produced on the premises the advantage in favor of the heating system would be greater. There seems little doubt that the large amount of heat now wasted by gas engines will gradually be applied to useful heating operations, as in the case of steam engines.

POWER FEATURES OF THE PARIS EXPOSITION.

By W. H. Donner.

AS an opportunity for the study of engineering, the two power houses of the Paris Exposition rank higher than those of any previous representative show. They are formed by the end sections of the principal buildings on the Champ de Mars, at the southern end, where they are connected by the Palace of Electricity. The engine rooms are each 380 feet long by 100 feet wide. One, situated on the eastern side of the Champ de Mars, is called the Bourdonnais station, and the other, on the western side, is the Suffren station, each taking its name from the neighbouring avenues which line the Champ de Mars. The Bourdonnais station has a further distinction, in that it represents the products of French engineers, while the Suffren station is devoted to foreign boilers and engines. A view of the Suffren boiler room is given below, showing some of the boilers being erected. In the foreground is a group of four, by Berninghaus, of Duisbourg, showing a combination of a Lancashire boiler below and a fire-tube boiler above. On the other side of the central passage are five boilers by Steinmuller, of Gummersbach, quite similar in general

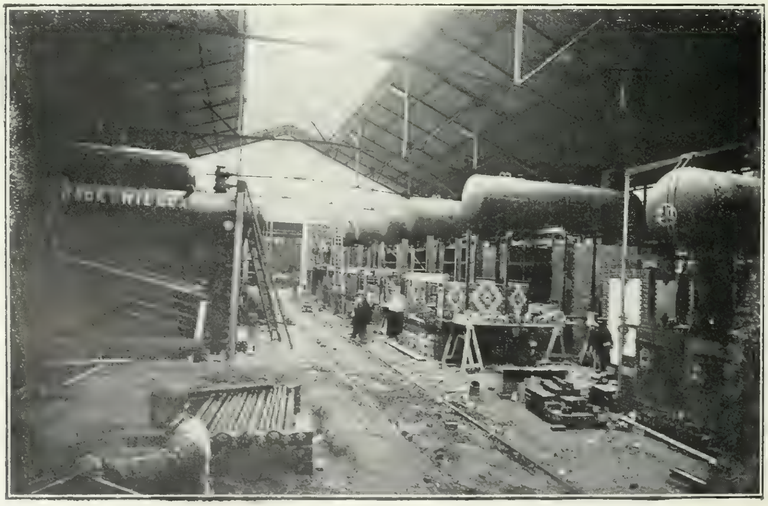


THE SUFFREN BOILER HOUSE AT THE OPENING OF THE EXPOSITION.

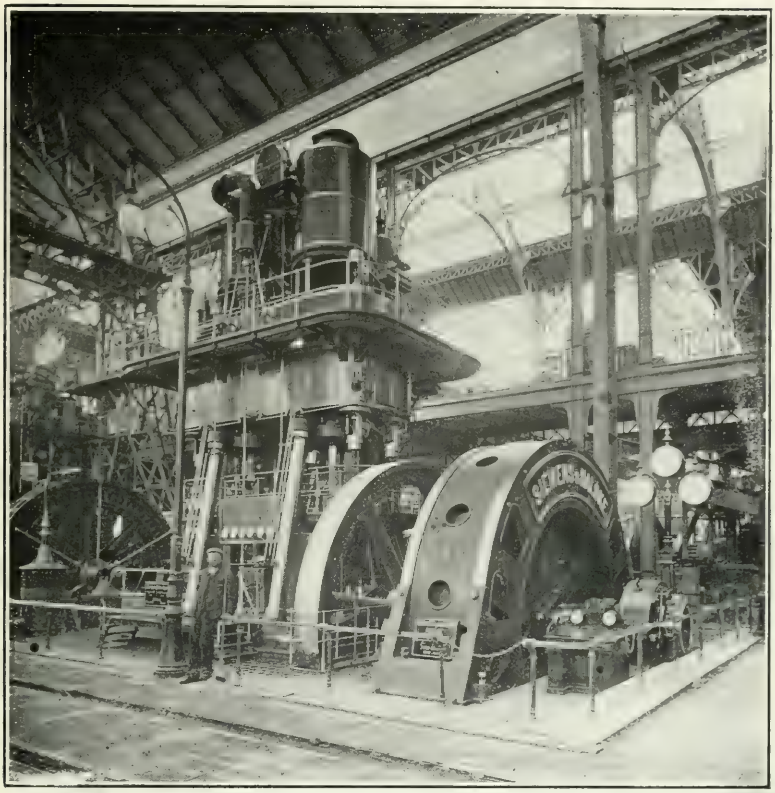
appearance to the Babcock & Wilcox water-tube boilers alongside. This latter company is also represented in the French boiler room, where there is a row of eight boilers of this make. Across from them is a battery of six water-tube boilers by De Naeyer & Co., of Willebroeck, and this station also contains twelve of the same type by J. & A. Niclausse, of Paris. Only four boilers are shown of the composite, or semi-tubular style, and none of the Lancashire type, there being a total of forty-five boilers of the water-tube design, which appears to be more in demand.

The main steam pipes are carried on the iron posts supporting the roof, and run down each side of the building, as may be seen on page 529. Two 10-inch pipes are provided, one above the other, and the steam is brought to two equalising cylinders before passing down into the subterranean passages built for the reception of pipes. One of these cylinders is clearly visible, alongside the square brick shaft which is placed at the end of one of the tunnels, for ventilation, and passes through the roof.

Among the engine builders the Germans have made a very creditable showing, as their large machines, direct-connected to well-known types of electric generators, were ready well in advance of the stipulated time, and would doubtless have been in running order on the opening day had the Exposition been ready with its service of steam and water. Only one, in the German group, is a horizontal engine, and is built by the Augsburg Engine Co. The other three engines



THE BOURDONNAIS BOILER HOUSE IN EARLY MAY.

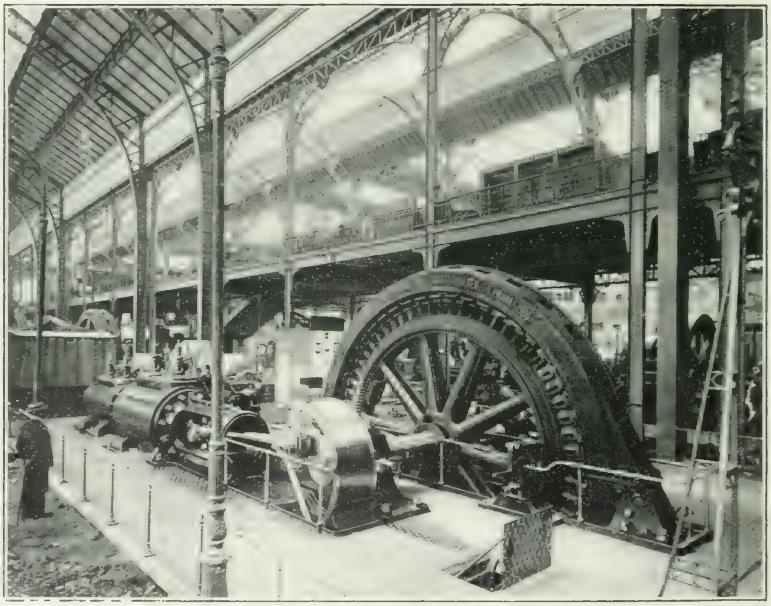


BORSIG ENGINE AND SIEMENS-HALSKE ALTERNATOR.

are vertical, one built by the Nuremberg Engine Co., one by the consolidated Augsburg-Nuremberg Co., and one by Borsig, of Berlin.

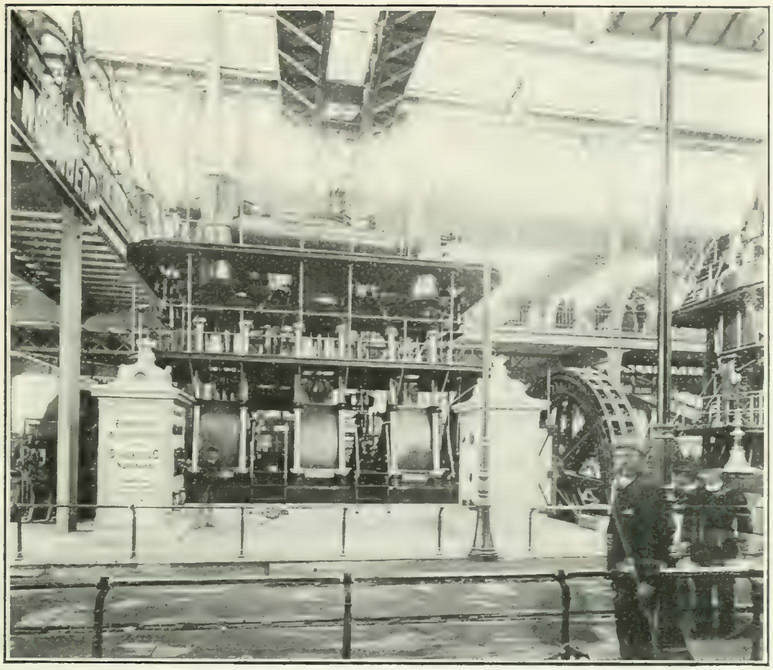
The three vertical engines of the German group are compound, triple-expansion three-cylinder, and triple-expansion four-cylinder, and of 1,500, 2,000, and 2,500 horse power respectively. The cut shows the largest of these, by Borsig, of Berlin, direct coupled to a three-phase 2,200-volt generator by Siemens & Halske. The sizes of the cylinders are 30 inches, 46½ inches, and 52¾ inches, with a stroke of 47¼ inches. In order to balance well in running, the cranks are placed at an angle of 180°. Beyond the Borsig engine is the three-cylinder engine by the consolidated Augsburg & Nuremberg Engine Co., giving an output of 2,000 horse power at 83 revolutions per minute, the same speed as the Borsig engine. The cylinders are approximately of the same dimensions, 30½ inches, 48¾ inches, and 71 inches, but the stroke is less by about 4 inches.

The Augsburg company make a specialty of horizontal engines, while the Nuremberg company build more of the vertical type. The horizontal engine, shown opposite, is triple-expansion, with four cylinders, and of 1,900 horse power with steam at the station pressure of 140 pounds per square inch. The shaft carries at its centre the revolving field of a 1,060-kilowatt Helios alternator, running at 70 revolutions per minute, and furnishing three-phase or single-phase current. The bearings of the shaft are 15 feet 6 inches between centres, and in diameter about 20 inches. One of the noteworthy features of this engine is the system adopted of arranging all the control in such a way that the regulating mechanism for both mechanical and electrical operation is readily accessible from one central point.

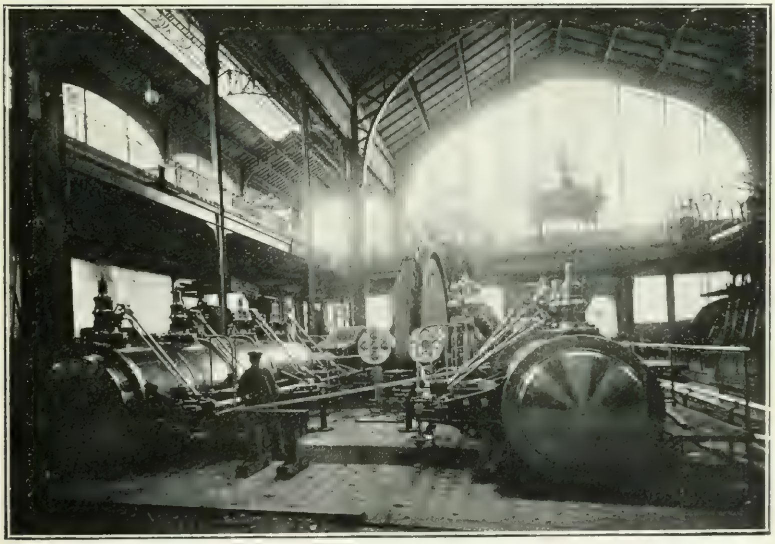


1,000 HORSE-POWER ENGINE, BY CARELS BROS., OF GHENT.

In the Belgian section we find a horizontal tandem-compound engine of 1,000 horse power, by Carels Bros., of Ghent, the cylinders being 26 inches and 41⅓ inches, and the stroke 45¼ inches. The valves rise vertically from the seat to admit steam, as is the case with several engines in the foreign station, and they are worked in this case by cams on a long transmission shaft driven by bevel gearing from the main shaft. The exhaust passes into a jet condenser under the floor level. We might make some comparisons between this engine,

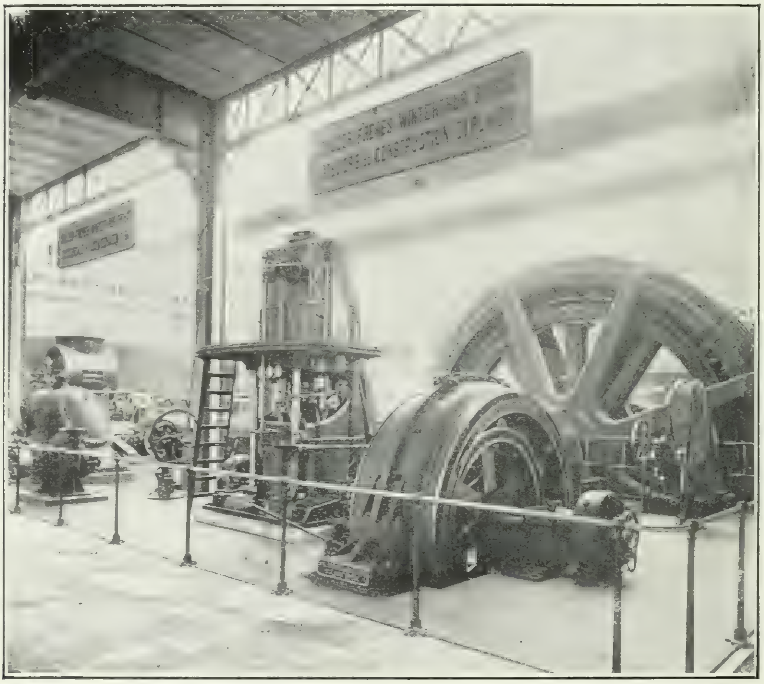


2,000 HORSE-POWER ENGINE BY THE NUREMBERG ENGINE CO., WITH DYNAMOS BY SHUCKERT & CO.



AUGSBURG ENGINE COMPANY'S 1,500 HORSE-POWER ENGINE AND HELIOS ALTERNATOR.

which is tandem-compound, and the single-cylinder Weyher & Richemond, both being of the same output. The stroke of the two engines is 45¼ inches and 39⅜ inches. Although the power is in both cases brought to bear on a single crank, the framing of the Belgian engine is lighter. The valves also are easier to inspect, as they are well separated and readily accessible, and the cylinder heads are left free. The valve motion of the Carels low-pressure cylinder is similar to that used in a new engine by Sulzer Bros., of Winterthur, Switzerland, who employ a rocking lever to raise a disc valve, giving a sudden quick movement immediately after the valve has begun to open.



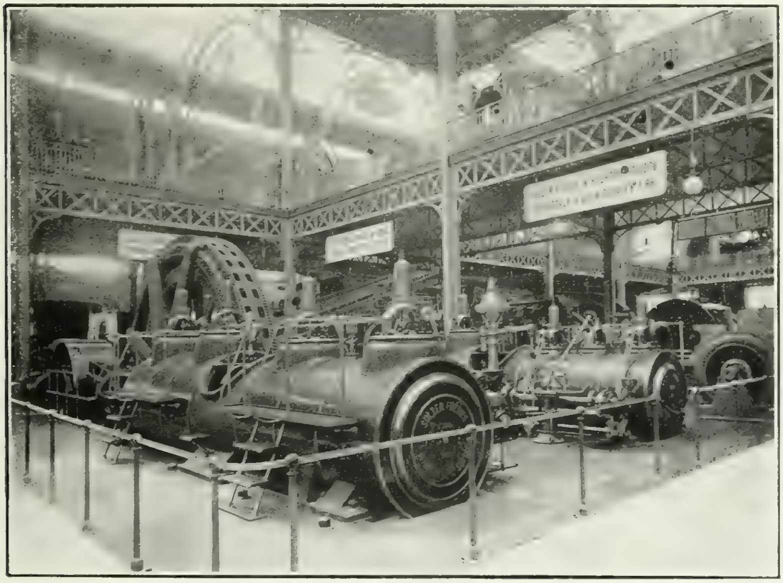
SULZER 400 HORSE-POWER HIGH-SPEED ENGINE.

Of the above engines the Augsburg & Nuremberg Co.'s machine shows the lowest piston speed, 598 feet per minute, and the Augsburg Engine Co. use a speed of 735 feet per minute. Borsig and Carels come between, with 654 feet and 709 feet per minute, respectively.

Sulzer Bros. have what is probably the finest exhibit of any one manufacturer. Only one of their machines is required for administrative lighting, but they have two large engines driving alternators, in addition to the small engine placed at the disposal of the Exposition.

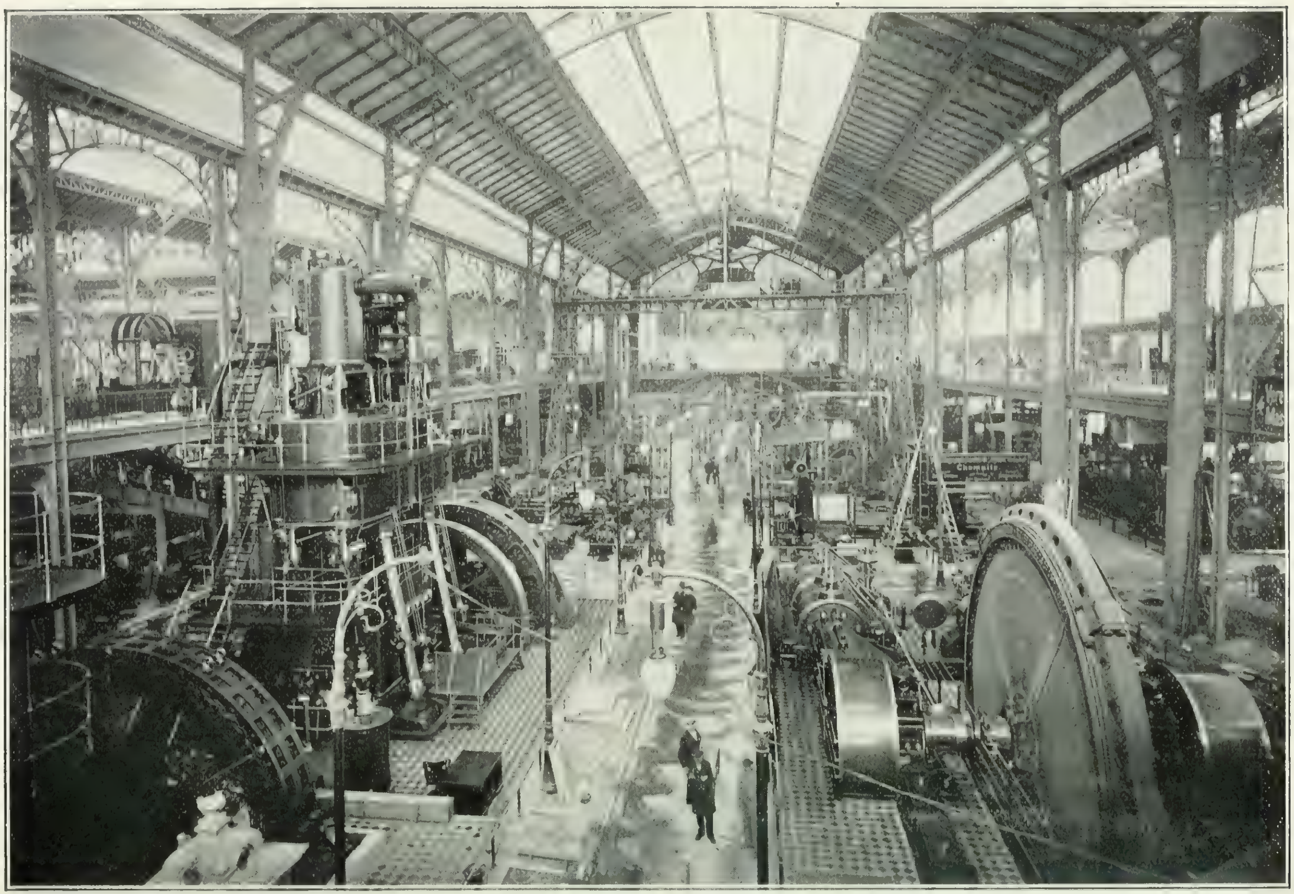
One of these engines, of 1,500 horse power, has four cylinders and makes use of triple expansion, the low-pressure cylinders being at the crank end. This construction was adopted in order to keep the cross-head cooler than was the case when the high-pressure cylinder was towards the crank, as in a previous design. This engine runs with great smoothness, and would doubtless give a good account of itself were it tested under load. The general effect of this installation is shown in the illustration below.

One of the neatest generating units in the Exposition is the vertical double compound 400 horse-power engine by Sulzer Bros., driving an alternator by the Oerlikon Co., and used for illuminations round the outer façade of the Champ de Mars buildings. The engine is of twin design, having two high-pressure and two low-pressure cylinders, and cranks at 180°. The valves of the corresponding cylinders are connected by rods which communicate identical motion to each set. The form of the valves is cylindrical, and steam admission and exhaust are obtained by a rotary movement.



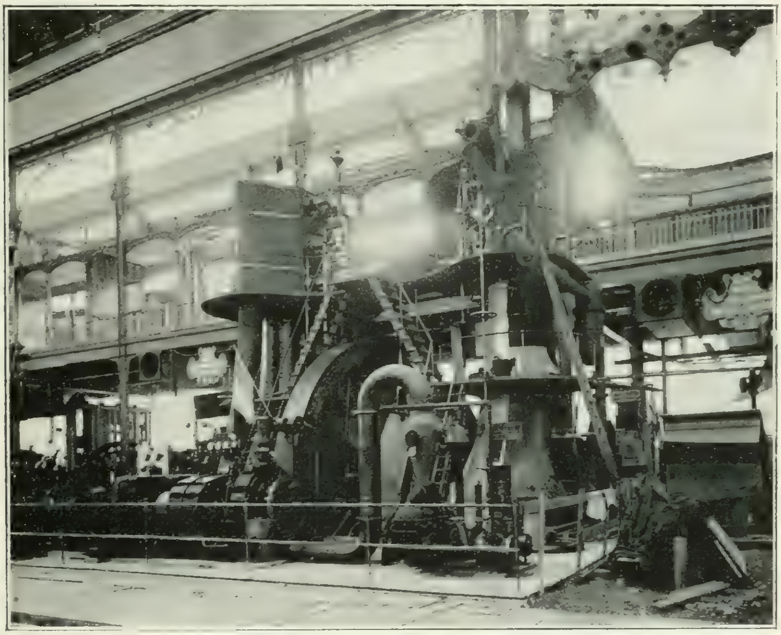
1,500 HORSE-POWER ENGINE BY SULZER BROS., OF WINTERTHUR.

The center of the foreign engine room is occupied by an exhibit of machine tools, as will be seen in the general view taken from one of the galleries. At the further end are visible the towering cylinders of the Willans 2,400 horse-power central-valve engine, in the section set apart for the British manufacturers. It is here that the work of instal-



GENERAL VIEW OF THE FOREIGN POWER HOUSE FROM THE GALLERY.

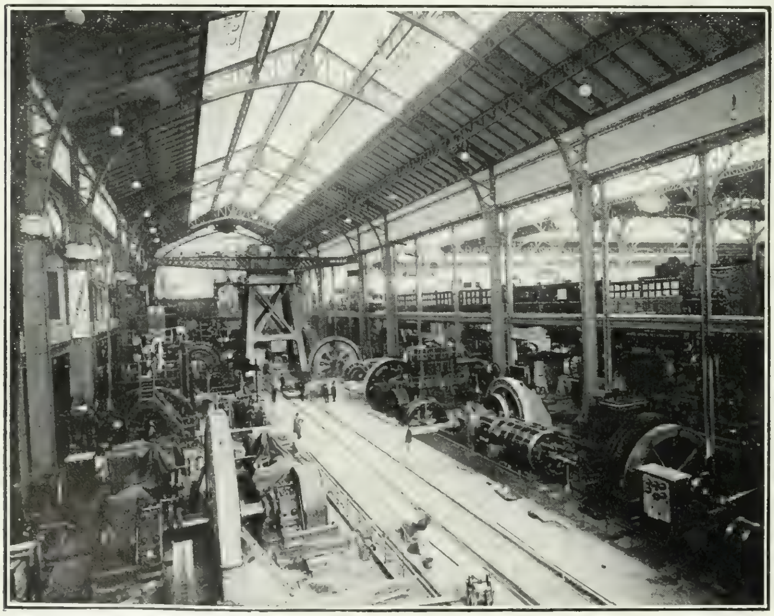
lation showed the most delay, as there were in some cases but foundations to be seen for some time after the day of inauguration of the Exposition. The transportation system was at fault throughout, especially with regard to machinery coming from over the sea. One of the finished exhibits at present is that of C. A. Parsons & Co., who have two steam turbines driving dynamos for lighting. Only one of these machines is connected to the steam mains; it is built over the condenser, which furnishes a rigid sub-base and concentrates the whole into a very small compass. In the French engine room there are two Laval turbines of 300 horse power each, furnishing current for lighting from their twin dynamos. The Parsons turbine is not required to supply current, as the number of machines on hand to draw from is greater than necessary, notwithstanding the brilliant illuminations to be provided later on. Close to one of the Laval turbines is what may be called an American exhibit—a vertical compound Reynolds-Corliss engine built by a French company (Anciens Etablissements Cail) from designs by E. P. Allis, of Milwaukee, and a three-phase 5,500-volt alternator by the Postel-Vinay Co. for the French Thomson-Houston Co. The United States are not represented further than this as engine builders; but it is to be remembered that most



E. P. ALLIS ENGINE AND DE LAVAL STEAM TURBINE.

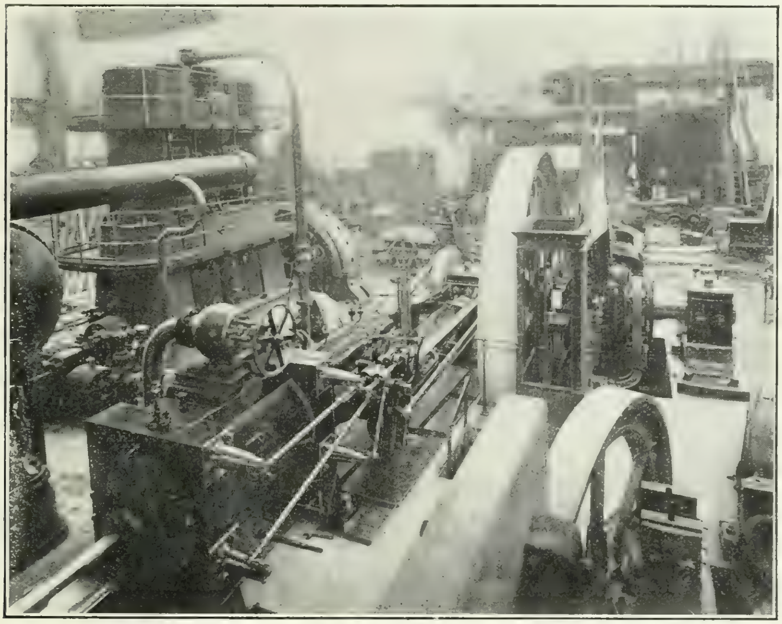
American manufacturers pay less attention to export trade than do other nations, who have not such an extensive home demand, and rights of construction for foreign countries are often sold outright.

Among the French engines of the Bourdonnais station there is much variety, and wide distinctions are made in design. One engine, which comes in for special comment and criticism, is of 1,000 horse power, all in one cylinder, and drives a direct-current 14-pole dynamo for incandescent lighting. Anticipating the objection which would naturally be made with regard to fluctuation in speed, a specially heavy flywheel is provided. This may serve the purpose very well, and the single cylinder certainly seems to find favour with the French, for there are five machines of that type in their section, although the foreign builders all use compound cylinders or triple expansion. Triple expansion, on the French side, is limited to two machines, one of which, a vertical enclosed engine of 1,250 horse power, by Delaunay-Belleville & Co., is shown on the left in Fig. 5. Four cylinders are used, the high-pressure and intermediate being above, and the two low-pressure cylinders below. The diameters of the cylinders are: high pressure, 19⅝ inches; intermediate, 24¾ inches; low pressure, each 33½ inches. The stroke is 50 centimetres, equal to the diameter of the high-pressure cylinder, giving a piston speed of 820



THE FRENCH POWER HOUSE, SEEN FROM THE GALLERY.

feet per minute at a rotative speed of 250 revolutions per minute. The generator on the extension of the shaft is a three-phase machine by Breguet, giving 700 kilowatts at 2,200 volts. The exciter is quite independent, and is driven by a de Laval steam turbine.

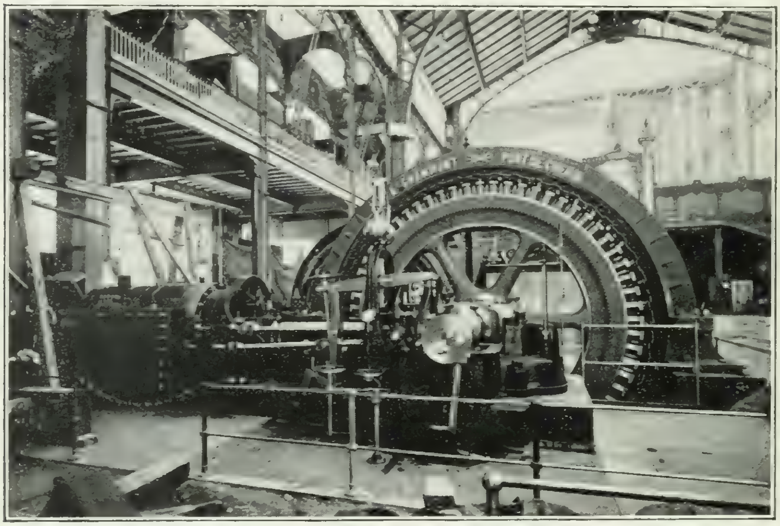


HORIZONTAL ENGINE BY E. GARNIER & FAURE BEAULIEU, AND VERTICAL ENGINE BY THE DELAUNAY-BELLEVILLE CO.

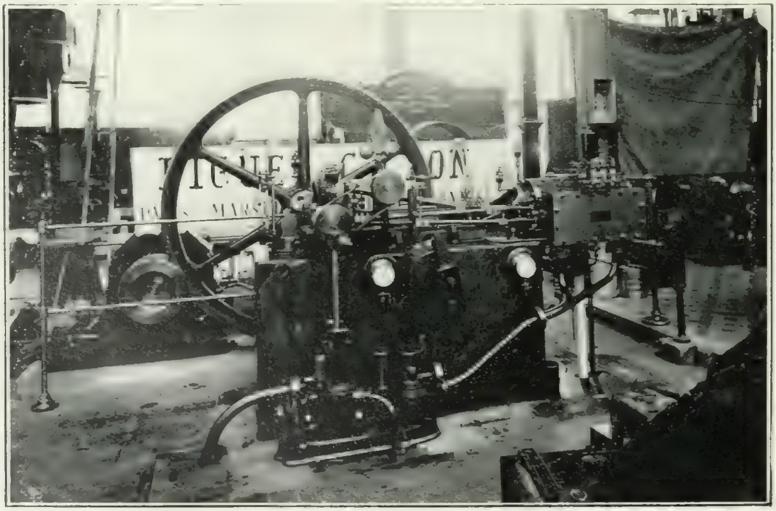
The horizontal engine above is by Garnier & Faure-Beaulieu, single-cylinder, condensing, 400 horse power, running at 90 revolutions per minute. The air pump is placed end on to the cylinder, instead of being driven from the crank pin as in the case of the foreign engines. The steam valves are of the Corliss type; in the triple-expansion engine above mentioned piston valves are used; and there is one example of a large engine of 600 horse power, by Piguet & Co., in which a flat slide-valve is used.

The greater number of the engines use the steam at the pressure of the mains, 140 pounds per square inch, but some of the German marine type engines were designed for 200-pound steam in regular use. The single-cylinder engines do not require even 140 pounds pressure, and four out of the five use reducing valves.

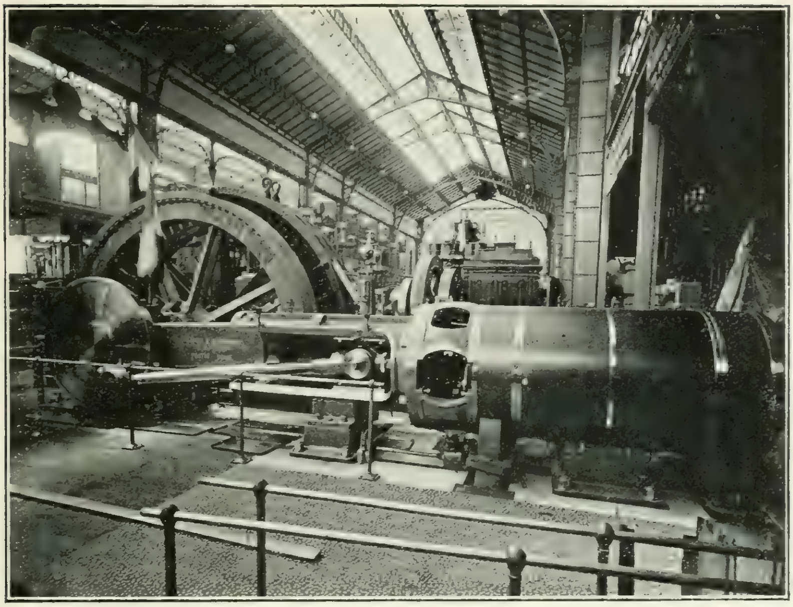
An interesting engine, but curious in some respects, is shown by Piguet & Co. in the French power house. This is a single cylinder 600 horse-power engine running at 94 revolutions per minute, and having a slide valve and cut-off valve such as one would expect to see only on engines of small power. The construction throughout seems heavy and the governor rather awkward, but the finish is excellent and the running smooth. The crosshead has no upper guide, so that the engine cannot run under. Close to this exhibit is a very small engine by the same maker, of only 25 horse power, having all the characteristics



600 HORSE-POWER ENGINE BY PIGUET & CO.

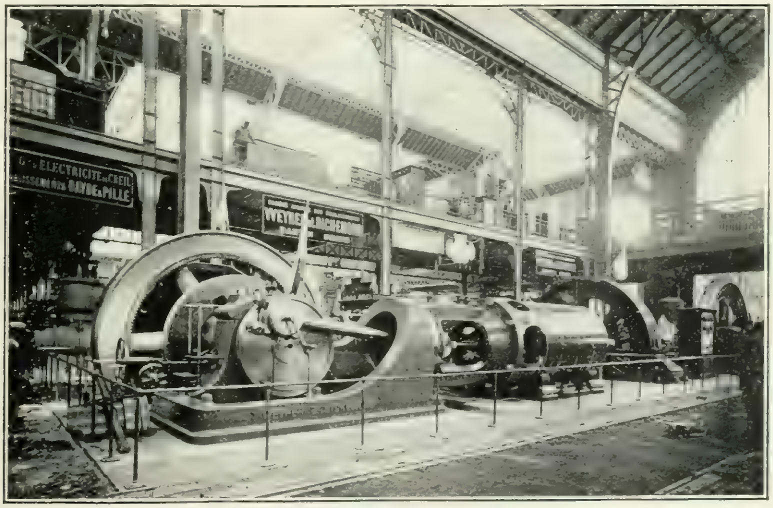


25 HORSE-POWER ENGINE BY PIGUET & CO.

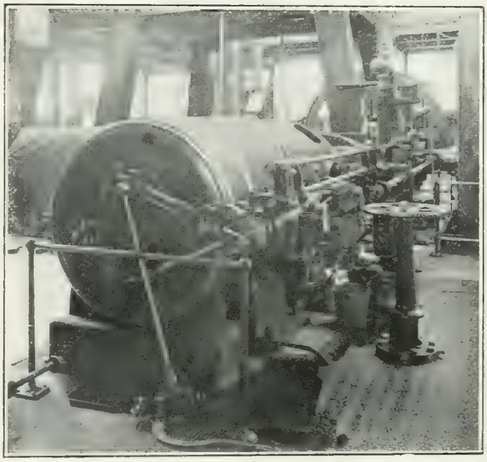


500 HORSE-POWER ENGINE BY WEYHER & RICHEMOND.

of the larger machine, which really appear more suitable when reduced to this size. Mounted on a raised platform, and provided with every appliance used on the 600 horse-power engine, it forms a pretty model. A small dynamo is driven from the flywheel by frictional contact.



WEYHER & RICHEMOND 1,000 HORSE-POWER SINGLE-CYLINDER ENGINE.

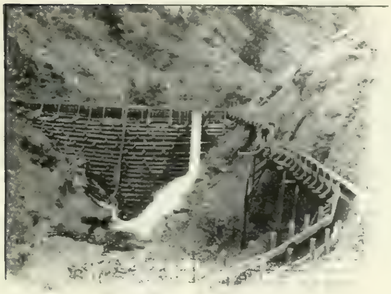


VALVE GEAR OF THE WEYHER & RICHEMOND 500 HORSE-POWER ENGINE.

The exhibit of Weyher & Richemond comprises three engines, two of 1,000 horse power and one of 500 horse power. One of the larger size, heavily built, has an exceptionally short stroke, and all of the power is obtained by the use of a single cylinder. This seems a daring extension of the design of the 500 horse-power engine which is set up at right angles to it in the space allotted to this company. The bedplate of the larger machine is considerably strengthened, as compared with the smaller, in order to secure sufficient rigidity. Some of the builders of triple-expansion engines in the foreign section hardly regard with favour such a decided variance from their own ideas of design; but there are advantages in a single-cylinder engine, such as simplicity of parts and ease of repair, even though the efficiency may not be quite so high. The cylinder diameter appears greater than it actually is, on account of the steam jacket, and, on the other hand, the length of the cylinder is less than the outside measurement by the space taken up at each end by the valve chests. The valves are operated from the main shaft by bevel gears and rods, instead of by eccentrics, and have a twisting motion on the cylinder heads, covering the steam ports with corresponding arms. From a practical standpoint these valves seem undesirable on account of difficulty of access, and some of the wearing parts of the mechanism are light. Both these engines will be running regularly as soon as the electric illuminations are in order, and a time test may show good qualities perhaps lacking in a more usual design.

THE HISTORY AND PROGRESS OF MINING IN BRITISH COLUMBIA.

By H. Mortimer Lamb.



THE first authenticated discovery of gold in British Columbia, according to Dr. G. M. Dawson, occurred at Mitchell or Gold Harbour, on the West Coast of Queen Charlotte Island, in 1851, a nugget weighing several ounces having been accidentally picked up by an Indian woman on the seashore. This nugget was brought to Fort Simpson, and coming into the possession of the officer in charge of the Hudson Bay Company's post at that place, was forwarded by him to the company's headquarters at Victoria. An expedition was at once fitted out and, proceeding to the spot, succeeded in locating a quartz vein 7 inches wide, "reported to contain 25 per cent. gold in some places."* The find was worked for some months and then abandoned, the narrow vein entirely giving out; no other indications of mineral were ever found on the island, notwithstanding that this extraordinary little seam of quartz had yielded, in the few weeks it was worked, a value of $20,000 on the word of one authority, or $75,000 on that of another. About the same time coal, which had been discovered on Vancouver Island as far back as 1835, began to be mined in earnest at Nanaimo.

But the Fraser River excitement of 1858 may be fairly described as the genesis of the mining industry in British Columbia. In the April of that year the first shipload† of 540 miners left San Francisco for the new El Dorado, and by the following June, it is estimated, over 14,000 persons had embarked from that port. But while this was the inauguration of gold mining in British Columbia, the actual returns of $543,000 for the season of 1858, from June to October inclusive, were considered disappointing, and so great were the natural difficulties of the country —unprovided, too, as it was then with means to support a large population—that a greater number of the immigrants returned to California early in the following year. In 1859-60 good diggings were discovered at Fountain, above Lilloett, on the Fraser River, on the Thompson River, the Similkameen River in the southern portion of the Province, at the forks of the Quesnelle River and at Antler Creek in the Cariboo district. But it was not until 1861 that the two most noteworthy discoveries of Williams and Lightning Creeks in the Cariboo district occurred and created a second considerable migration of miners to western Canada, which increased in volume until 1864. The average value of gold obtained per lineal foot of channel of certain claims on Williams Creek is given in the report of the provincial minister of mines for 1875 as $1,075. The production of Lightning Creek, while less in the aggregate than Williams, was greater while it lasted, and from this creek alone gold to the value of $2,179,272 was extracted. As will be seen from the accompanying chart, the maximum production of placer gold was reached in 1863, when the output, almost entirely from the Cariboo district and from Wild Horse Creek in South East Kootenay, was $3,913,563, and the average annual earnings per man, $889. Until 1867 the production gradually but steadily decreased, although previout to that year fresh discoveries of alluvial gold were made at Leech River, on Vancouver Island, and at the bend of the Columbia River, in north Kootenay. The increased production in 1868-69 and in 1874-75-

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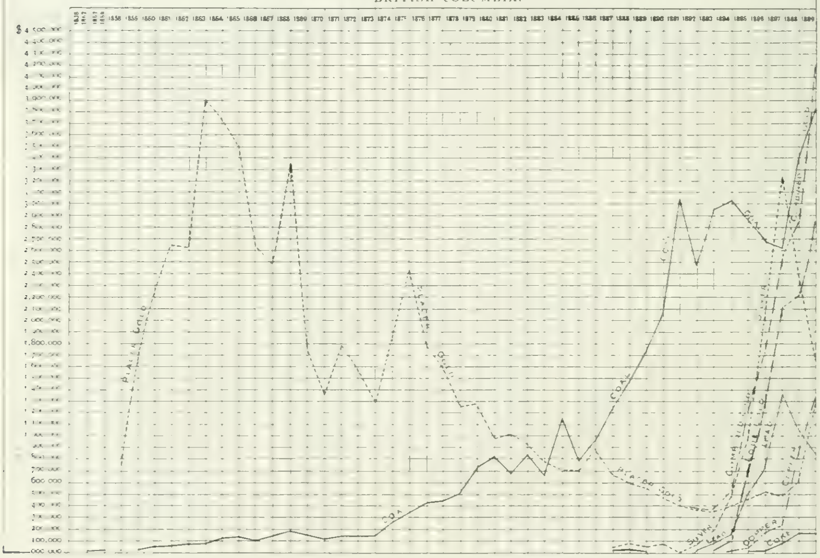
* Mineral Wealth of British Columbia; Geol. Survey Canada, 1888.

† Bancroft's History of British Columbia.

TABLE
SHOWING MINERAL PRODUCTION
OF
BRITISH COLUMBIA.

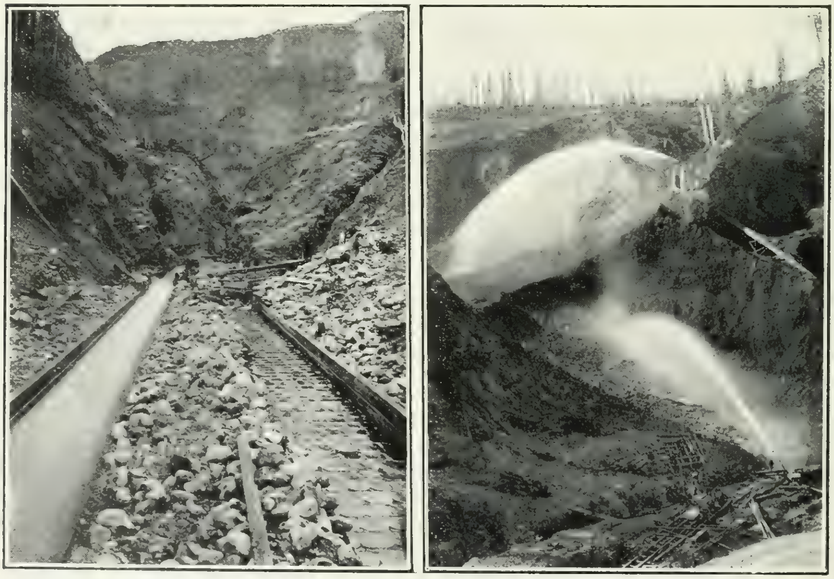


COAL SHIPMENT WHARF AT PROTECTION ISLAND, NANAIMO, B. C.

76 is doubtless due to respectively the discoveries in the Omineca district, near latitude 56, and in Cassiar, still farther north. From this latter district gold to the value of $1,000,000 was taken out in 1874, this being more than 50 per cent. of the total production of the country for that year. In 1888 the value of the production of placer gold had fallen to not much above half a million dollars. Whereas in 1875 the number of miners employed was 2,024 and the annual average earnings per man $1,222, in 1888 the average individual earning was but

NO. 1 SHAFT, NEW VANCOUVER COAL CO., NANAIMO, B. C.

$307 for 2,007 men employed. The early miners worked the bars, the outcrops of the coarser wash in the terraces, and the creek and bench deposits, with no other appliances than picks and shovels, rockers and sluices. In the deeper ground in the Cariboo district sinking and drifting was resorted to, but here, too, only apparatus of the crudest, hand-manufactured type was in use. Early in the 70's, hydraulicking was attempted with cotton hose and with perhaps a 2-inch nozzle and rarely more than a hundred feet of pressure. Within the last six or seven years, however, the old—and, so far as the individual miner is concerned, worked-out—diggings of Cariboo, Omenica and Cassiar have become re-vitalised. In these districts some very important enterprises, involving large capital expenditures, are being conducted under the supervision of highly trained and skilled engineers. As yet in no instance has the success in these several undertakings been quite reached, although several are within a measurable distance of that consummation. Some of the Cariboo hydraulic schemes, in particular, by their magnitude are worthy of special mention. One of these was an undertaking which was carried out at a cost of $250,000, to dam back the waters of the Quesnelle Lake at its foot, and where the South Fork of the Quesnelle River, as it leaves, is a little more than 400 feet wide. In the past a great quantity of gold had been won from the bars and bottom of this river; but it was thought that owing to the rapid flow of


A CANAL AND SLUICE, AND HYDRAULIC MINING IN THE CARIBOO DISTRICT.

the stream (which runs 12,000 cubic feet per second in low water and 24,000 cubic feet in high water, in a succession of rapids between canyon-like gorges), the gold could not have been recovered from the main channel with the primitive methods employed at the earlier period, and consequently that by erecting a barrier at the outlet of the lake this channel could be laid bare and the gold recovered during the season of low water in the early spring and autumn months. The conception was sufficiently bold and even plausible, but since the dam was completed the result of preliminary work in gold getting has hardly as yet justified the high expectations of the originators of the project.

THE DAM AT THE OUTLET OF QUESNELLE LAKE.

Another big enterprise, comparing favourably with any of a like nature in the world, comprises the mining by hydraulic process of a property in the same neighbourhood, aggregating 2,554 acres, and covering for a distance of about ten miles the auriferous deposits of a system of ancient rivers. These deposits vary from 400 to 600 feet in depth from surface to bottom of channel, and it is estimated contain 500,000,000 cubic yards of high-grade auriferous gravel available for future washing, the average gold tenure being modestly computed at 20 cents per cubic yard, and the total gold content at $100,000,000. The equipment at this mine consists of a portable hydraulic plant of four lines of 30-inch and 22-inch riveted steel pipes, aggregating 6,000 feet; six No. 8 hydraulic giants with deflecting nozzles, varying from 6 to 10 inches in diameter; and the gold-saving appliances include a double extended system of sluices, 7 feet wide by 4 feet deep, aggregating 2,380 feet in length. The sluices are paved partially with end-wood sluice blocks 1 foot thick, and partially with improved longitudinal steel riffles, while the installation is about to be made of two improved undercurrents intended for the recovery of flour quicksilver, fine gold, platinum, and osmiridium that cannot be saved in the ordinary sluice. A few figures relative to the operation of this property during the last three years may prove interesting:

Gravel Washed, Cubic Yards.	Duty per Miner's Inch, Cubic Yards.	Value per Cubic Yard (Cents.)
1897.		
413,058, mostly top gravel,	$3.84	$17.20
345,231, " " "	3.44	16.10
*81,817, " " "	5.12	6.90
1898.		
350.000, " " "	2 44	21.00
35,070, bottom gravel,	1.10	67.15

Operating Expenses.	Cents per Cubic Yard.
Labour	$3.80
Explosives	2.40
Maintenauce of Plant	2.58
Management and Office Expenses	1.05
Sundries	1.77
	$11.60

Gravel Washed, Cubic Yards.	Average Value (Cents).	Cost (Cents).
1899.		
1,052,535, gravel, boulders, etc.,	$27.10	$9.54

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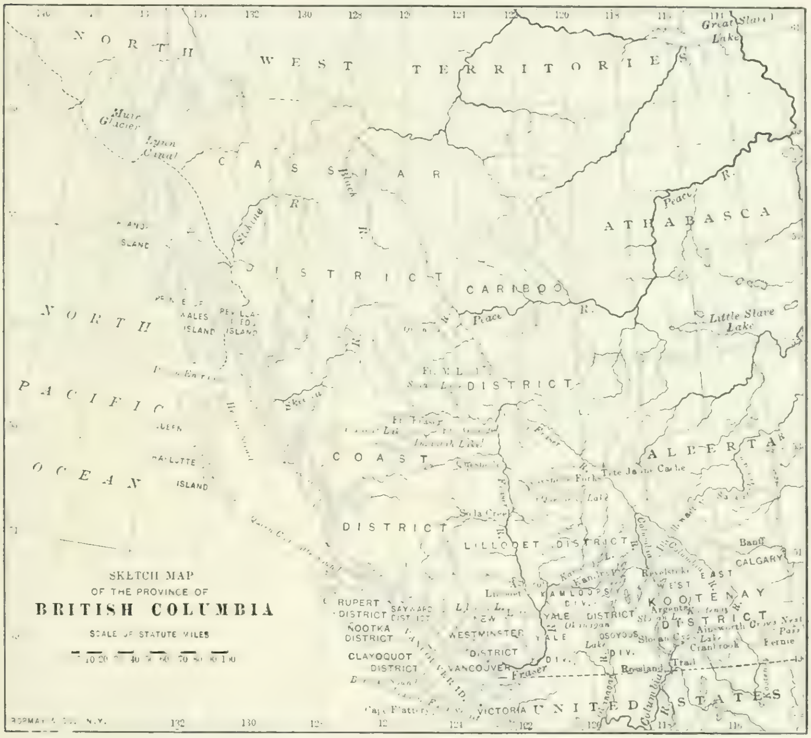
* Mostly boulder clay.

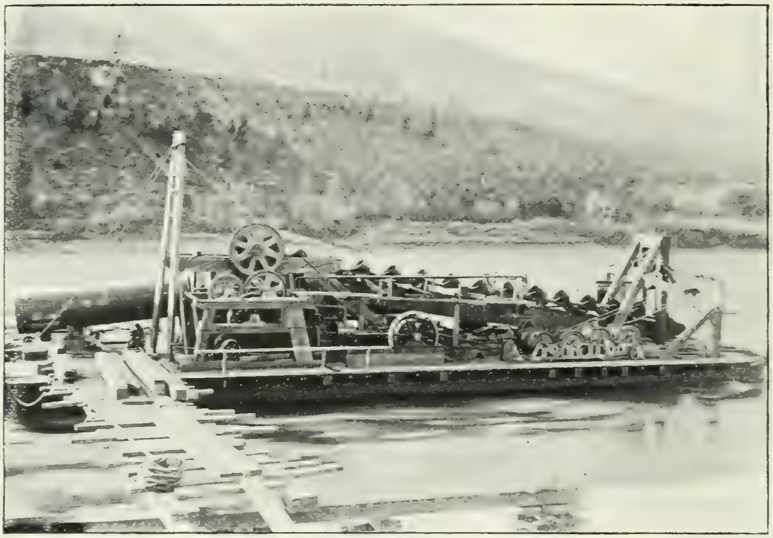
It is only fair to add that these costs of operation will be still further reduced in the near future.

On another property an interesting mining problem under entirely different conditions has been developed in a gravel deposit five miles south of Quesnelle Lake. Here the bed of the channel has been found to dip at a very flat angle, and the entire gravel bank has become a hard cemented mass. An attempt was first made to work this out with monitors, but as the face advanced the gravel began to get harder, and as the amount of cement was increased the wall was broken down with enormous charges of powder; but hydraulicking was found to be unavailing in disintegrating the masses thus shattered, which were swept with most of the contained gold out to the dump. Milling tests of a favourable nature having been made in San Francisco, giving gold returns of $4.85 and up to $5.56, a tentative plant was erected consisting of two self-feeders, two batteries of five stamps of 850 lbs., drop 7 inches, 90 to 100 per minute. From the mill returns it has been shown that with the ten-stamp battery 135 tons of cemented gravel can be crushed per twenty-four hours. The total cost of mining and milling has not exceeded $1.40 per ton.



Although the opportunities for the remunerative investment of capital in alluvial mining in this district are good, some time must elapse before the field is thoroughly exploited, and while there is abundant evidence of quartz leads, values are too low to permit of profitable mining under existing conditions of labour and transport. In the early 60's the cost of transportation of supplies from the sea-board to the mines was a dollar per pound. The present rate is from six to seven cents, and thus the freight charges on mining machinery and supplies are still not infrequently greater than the first cost of the articles themselves.

Some attempts have been made to dredge the bottoms and bars in the upper Fraser and Quesnelle rivers; but as these undertakings were often begun without due inquiry or investigation, and again because they were conducted by men lacking in experience, and the suction-



A DREDGE ON THE FRASER RIVER, IN COURSE OF CONSTRUCTION.

pump type of dredge generally used was unsuitable, very limited success has attended effort in this direction in the past. It remains to be seen whether better results will attend the use of dredges built after the New Zealand pattern, which have lately been introduced; but in the majority of the rivers and streams the velocity of the currents and the size of the boulders in the channels present serious difficulties.

The revival of placer gold mining in British Columbia, of which

VAN WINKLE BAR GOLD MINE, FRASER RIVER, NEAR LYTTON, B C.

THE DISCOVERY CLAIM, PINE CREEK, ATLIN DISTRICT.

the evidence is the gradually increasing production, while ascribable in part to the adoption of modern gold-mining methods, is also due to the recent discovery in the extreme northern limits of the province, and east of the Pacific Coast mountain ranges, of alluvial gold deposits of very fair promise. From this district last year royalty was paid on 26,579.52 ounces of gold. The discovery of this field is quite recent and consequently only primitive processes of gold-mining have been as yet

MINING ON PINE CREEK IN THE ATLIN DISTRICT.

applied, but to deal with the conditions economically hydraulic methods—including in places the use of elevators—will have to be resorted to, when the best results may be anticipated. But placer mining, as compared with lode mining, takes, in the consideration of the British Columbia industry, quite a secondary place in point of importance, although the latter is of relatively recent origin and growth.

CHAIN PUMPS AT WORK ON PINE CREEK, IN THE ATLIN DISTRICT.

Seventy years ago the Hudson Bay Company discovered and worked a galena vein in the Ainsworth district of West Kootenay, converting the ore into bullets for trade with the Indians; but productive mining in the Kootenays and other quartz districts can not be said to have actually commenced prior to 1887. About that year prospectors, of which the neighbouring States to the south had bred a sturdy class, began, in spite of the incredible physical difficulties of an unexplored, mountainous, and heavily timbered country, to turn their attention to the territory adjacent to Kootenay Lake and the Columbia River, to East Kootenay and the interior plateau; but with the exception of the Hall group of mines near Nelson, no notable discoveries were made until the summer of 1890. In July of that year all the more important mines of the Rossland camp were located, including the Le Roi, War Eagle, and Centre Star, and the autumn of the following year witnessed the discovery of the extraordinarily rich silver-lead mines of the Slocan region. From this time onward prospecting was vigorously prosecuted throughout the southern and central portions of the province, the whole of which has been found to be more or less richly mineralised. In view of the fact that the first discoveries occurred but seven or eight years ago, it is hardly necessary to state that lode mining in British Columbia is yet in its infancy. Nevertheless the development and progress made in this short period of time is very strikingly evidenced in the following table* of production of lode mines:

Year	Gold.		Silver.		Lead.		Copper.		Total Values.
	Oz.	Value	Oz	Value.	Pounds.	Value	Pounds.	Value.	
1887	......	....	17,690	$17,331	204,800	$9,216	....	.. ..	$26,547
1888	......	....	79,780	75,000	674 500	29,813	....	....	104,813
1889	......	....	53,192	47,873	165,100	6,498	....	... .	54,371
1890	......	....	70,427	73,948	*Nil.*	*Nil.*	....	....	73,948
1891	......	....	4,500	4,000	*Nil.*	*Nil.*	....	....	4,000
1892	......	....	77,160	66,935	808,420	33,064	....	....	99,999
1893	1,170	$23,404	227,000	195,000	2,135,023	78,996	....	....	297,400
1894	6,252	125,014	746,379	470,219	5,662,523	169,875	324,680	$16,234	781,342
1895	39,264	785,271	1,496,522	977,229	16,475,464	532,255	952,840	47,642	2,342,397
1896	62 259	1 244,180	3,135,343	2,100,689	24 199,977	721,384	3,818,556	190,926	4,257,179
1897	106,141	2 122,820	5,472,971	3,272,836	38,841,135	1,390,517	5 325,180	266,258	7,052,431
1898	110,061	2 201,217	4,292,401	2,375 841	31 693 559	1,077,581	7,271,678	874,781	6,529,420
1899	138,315	2,857,573	2 939,413	1,663,708	21,862,436	878,870	7,722 591	1,351 453	6,751,604
	463,462	$9,359,479	18,612,778	$11,340,609	142,722,937	$4,928,069	25,415,525	$2,747,294	$28,375,451

As will be noticed, silver and lead were the first minerals produced, and the circumstances may be largely explained on the ground of the exceptional richness of the galena ores of the country, and more especially of those of the Slocan district. Thanks to these high-grade qualities the original discoverers in many instances succeeded in working the properties with profit from the "grass-roots" without the assistance of capital. Thus, before railways were constructed through this district, a relatively large quantity of ore was mined and "packed" out on horseback a distance of 17 miles through thick forest to a point on Kootenay Lake, at a cost of from $40 to $45 per ton. It was then forwarded by boat and rail to smelters in the United States at a further cost of $20 a ton. Add to this the cost of mining and treatment,

KOOTENAY LAKE, BRITISH COLUMBIA.

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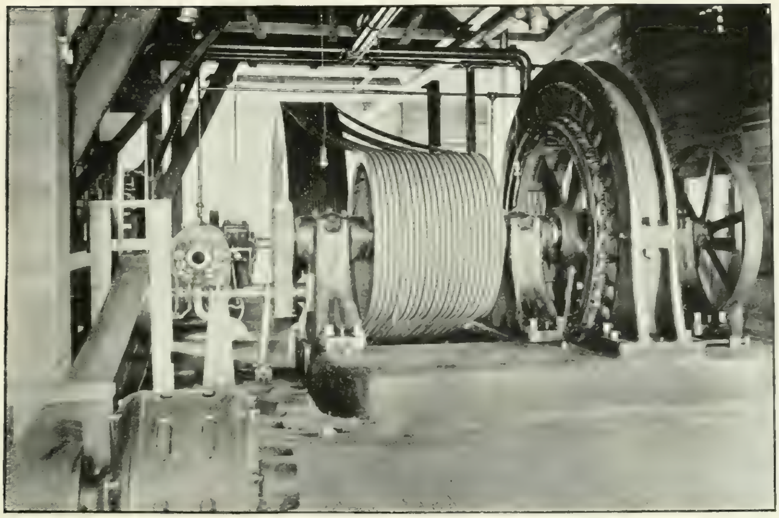
* From advance sheets Minister of Mines' Report, 1900.

and it will be readily admitted that only remarkably high-grade ore could stand so heavy a tax and yet admit of profitable extraction. From facts at my disposal, I do not hesitate to assert that the average metallic percentages of some of the Slocan argentiferous ores cannot be bettered in any other part of the world.

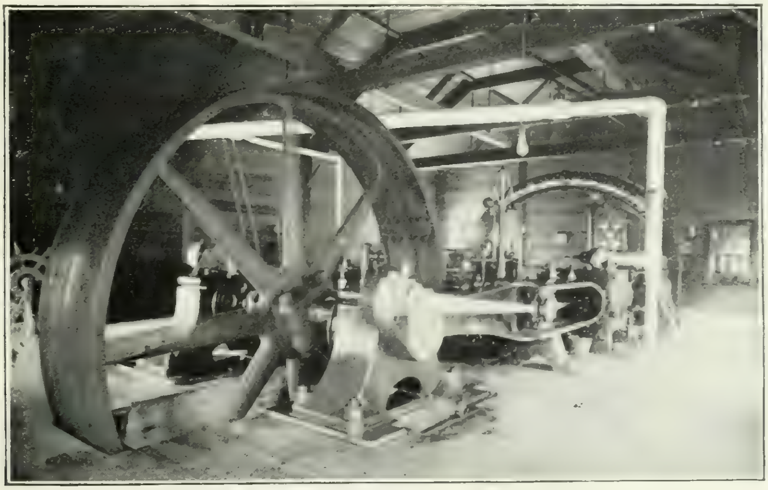
With the completion in 1894-95 of railways, the construction of which was not unattended with engineering difficulties, having regard to the high altitudes and the mountainous character of the country generally—an era of active mining development on a much more extensive scale was inaugurated, each year thereafter, until 1898, showing an increase of output of considerably more than 100 per cent. The maximum production was reached in 1897. The unusually low price of silver towards the close of that year and in the spring of 1898, together with the uncertainty as to the future price of the metal, and furthermore the increase of the duty on lead imported into the United States—our principal market—acted as a serious check to the young industry; and when, towards the close of the year, the price of silver again advanced, it had become too late for the resumption of shipments. Meanwhile at many of the larger producers advantage was taken of the opportunity to extend development operations and to block out ore-bodies. Hence the outlook for an exceptionally large production last year was peculiarly bright. These prospects would

FACE OF TUNNEL, CLIFF MINE, ROSSLAND, B. C.
About 300 feet in.



AIR COMPRESSOR AT WAR EAGLE MINE, ROSSLAND.

certainly have been realised but for the unfortunate passage of an act by the provincial legislature limiting the day's work underground in metalliferous mines to 8 hours, under a penalty. While this legislation may not have been the direct cause of the friction which subsequently ensued between masters and men, it certainly precipitated matters, the result of which was the closing down of the majority of the Slocan mines from June to December. Previous to the passage or this act the miners in this district were paid $3.50 for a working day



BLACK BEAR AIR COMPRESSOR, ROSSLAND CAMP.

of nominally 10 hours. The actual time, however, spent in the breast was rarely more than 9 hours. When the "8-hour law" came into force the miners, through their local unions, refused to accept a corresponding reduction of wage, giving as reasons for their refusal the contentions that (1) the average miner would do as much work in 8 hours as in 10; and (2)—which would seem to be a still less rational argument—"that the Slocan mines are so rich that the owners can afford to pay higher wages." Both sides remaining obdurate, the mines were closed until quite recently, when a compromise was at length effected, the owners offering and the men accepting a wage of $3.25 for a working day of 8 hours.

It should be stated that there is no economic problem in Western Canada to-day representing greater difficulties of solution than that involved in the question of the general inefficiency and unproductiveness of labour in this country in relation to its cost. The mean standard of efficiency of miners in British Columbia is markedly lower than in any other mining territory in North America; yet the scale of wage is as high as, if not higher than, that in force in most parts of the United States. But it is upon that country that British Columbia is chiefly dependent for skilled mine labour, and as the inducements offered are not sufficiently great to induce to any considerable extent immigration of men who at home are certain of employment at a highly remunerative rate of wage, skilled American miners are in the minority and a large portion of the labour employed in the British Columbia mines is, therefore, made up of a heterogenous class com-

CONCENTRATOR IN THE AINSWORTH DISTRICT.

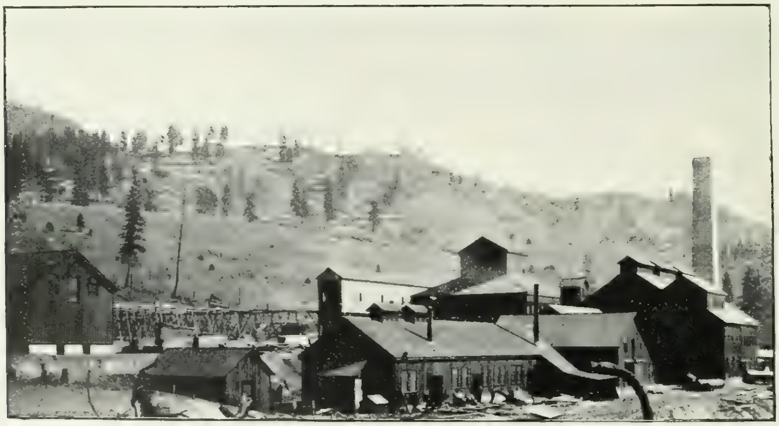
THE CANADIAN SMELTING WORKS, TRAIL, B. C.

posed of lumbermen, farm and railway hands and navvies, who nevertheless are as highly paid as their more experienced and qualified colleagues. Consequently when questions of dispute arise between capital and labour the men have the great advantage, of which both sides are aware, in that the expert miners can threaten to leave the country if a protracted settlement appears likely. In the recent Slocan labour troubles, the railways, it is affirmed, made good the losses sustained in the suspension of ore shipments by the transport of miners returning to the United States.

Another drawback to mining in the Slocan, although this condition may shortly be ameliorated, is the cost of marketing the ores. When the ore reaches the surface it is either sorted by hand or concentrated by machinery of the usual type. In the concentration there is often much loss of silver with the tailings, which is unavoidable; and so long as the silver-bearing minerals thrown off from the mill have a value less than the cost of freight and treatment, their rejection is explainable. But the silver thus deposited in the tailings may afterwards be recovered by other methods and yield a profit when shipped in a concentrated form, and when local smelting is established close dressing will become more necessary. After this preliminary dressing the ores are mainly consigned to Colorado for smelter treatment, the cost of carriage ranging from $11 to $19 per ton.

Although in the official reports the date of the commencement of copper production is given as 1894, as a matter of fact the first shipment of 100 tons of copper ore was made in 1888-9 from the Hall group of mines near Nelson, the value of the product being from 220.5

ounces silver and 17 per cent. copper to 574 ounces silver and 43.36 per cent. copper per ton. Also a shipment of 10 tons was made from Rossland in 1891 and of 700 tons in 1893. It is interesting, by-the-way, to note in connection with this first shipment from Rossland that the exceptionally high smelter returns of $84 per ton, or 3 ounces silver, 5.21 per cent. copper, and about 4 ounces of gold, practically established that camp. The consignment, packed over 12 miles of rough trail to the Columbia River, was sent from the Le Roi mine by a small syndicate of Spokane, Washington, speculators to whom the property was under bond, and who subsequently made a very large fortune as a result of their investment. Until the spring of 1895, however, the progress of mining in this district was comparatively slow, and it is said that no less than forty-two "experts" had in the interim condemned the camp as worthless. But in 1895, on the strength of a contract from the Le Roi Company to supply 75,000 tons of ore (on half of which a fixed charge of $11 a ton for freight and treatment was arranged), a land grant from the Provincial Government, and a bonus from the Dominion Government of $1 on each ton of ore smelted, a smelter was erected on the Columbia River at Trail and a narrow-gauge railway built between the mine and the works. As the crow flies this distance is only 4 or 5 miles, but to overcome the difference in elevation of about 2,100 feet between Trail and Rossland, the switchback arrangement was employed, thus lengthening the line to over 11 miles. After the erection of the smelter, the cost of freight and treatment for nearly two years remained unchanged at $10 to $14 per ton, 95 per cent. of the assay value of the gold and silver being paid for and a deduction made of 1.3 from the percentage of copper present.



NEW SMELTER IN THE BOUNDARY CREEK DISTRICT.

With the completion of their contract with the Trail smelter, the owners of the Le Roi mine erected works of their own immediately across the boundary at Northport, Washington, and succeeded in reducing their smelter costs to some extent. But with the acquisition of the Trail smelter by the Canadian Pacific Railway Co. freight and treatment charges were immediately cut down to $7 per ton. The chief cause of this reduction in costs was the great cheapening of fuel following the development of the Crow's Nest Pass coal fields. That the present treatment charges may still be considerably lowered is quite probable, for according to the report of the Le Roi Company last August, the cost of treatment at the Northport smelter was only $3.

CYANIDE WORKS AT THE DOROTHY MORETON MINE, WEST COAST OF MAINLAND, BRITISH COLUMBIA.

The only instance of the adoption of the cyanide treatment in British Columbia.

In connection with the reduction of freight and treatment charges, the following table giving the actual yield values, according to smelter returns, of Rossland ores for the years 1894 to 1897 inclusive, is interesting as showing the increase of tonnage and gradual decrease of values as it became possible to extract profitably lower grade ores:

Year.	Tons (2,000 lbs.).	Gold (Ounces).	Silver (Ounces).	Copper.	Value.
1894	1,856	2.00	2.80	2.85%	$40.69
1895	19,693	1.60	2.41	2.10 "	35.67
1896	38,075	1.45	2.34	2.08 "	32.65
1897	68,804	1.42	1.60	1.32 "	30.48

In 1898 the average value per ton on a production of 111,282 tons was $22.80; and in 1899, $18 on a production of 185,000 tons. On this last there is still left a very fair margin of profit, and ore as low grade as $7.50 was profitably mined last year. In the past two years the Rossland mines have been equipped with costly machinery of the most recent design, and with electric power-transmission, the working of the mines on the contract system, and other innovations, the outlook for the future is very bright. To show further the condition of mining in the Rossland district, I append an excerpt from a recent report of the War Eagle Mining Company, comparing the cost of development and ore extraction from January, 1897, to December 31st, 1899:

THE MOTHER LODE MINE, BOUNDARY CREEK DISTRICT.
The vein is more than 200 feet wide.

Date.	Cost of Development per Ton of Ore Sold.	Cost of Ore Extraction per Ton of Ore Sold.	Total Cost of Mining.
January to September, 1897	$10.67	$2.11	$12.78
October, 1897, to September, 1898.	4.32	2.98	7.30
October, 1898, to September, 1899.	1.71	3.58	5.29
October, 1899, to December, 1899.	1.80	3.42	5.42

Up to the present time almost the entire metalliferous production of British Columbia has been derived from the two districts of Slocan and Rossland, but in the near future the productive area will be vastly augmented as a result of the development which has of recent years taken place in East Kootenay and also in what is known as the "boundary country," forty miles west of Rossland and immediately north of the international boundary line. The latter district is of exceptional interest on account of the very extraordinary size of the deposits found there, some of which are considerably more than 100 and, in one or two cases, 200 feet wide. The characteristic ore—an iron sulphide carrying gold and copper—is, however, speaking generally, of low-grade value, not averaging over $10 or $12 per ton. Accu-

BOILER PLANT, MOTHER LODE MINE, BOUNDARY CREEK DISTRICT.

These boilers were hauled in a distance of 65 miles on waggons.

rate sampling is a very difficult matter, as the ore will range from a barren pyrrhotite to another, of very similar appearance, carrying high gold values, while the copper contents in different parts of the same ore-body will vary proportionately as much. Where concentration is practicable it will undoubtedly be resorted to and some very interesting tests in this direction have been made by a local engineer, who sends me the following particulars:

1. The magnetic oxides cannot be concentrated except by magnetic separators, followed by water concentration. With this plan concentration is very complete.

2. The calcite and siliceous ores can be concentrated, the first more completely than the second.

3. The proportion of gold saved in the concentrates will be close to, if not exceeding, 95 per cent. of all gold present in ore.

4. The proportion of copper saved will vary from 60 to 80 per cent., according to the degree in which formation of slimes can be obviated and the degree in which those formed can be concentrated.

5. The ratio of concentration will average about three tons into one.

Two large smelters are now in course of erection in the district, and it is stated that the charge for treatment will not exceed from $3.50 to $4 per ton, owing to the self-fluxing character of the ores; but even with this cheap rate, the utmost economy in working will need to be observed to ensure success. The completion last year of a railway

GALLOWS FRAME AND HOIST IN POSITION, MOTHER LODE MINE.

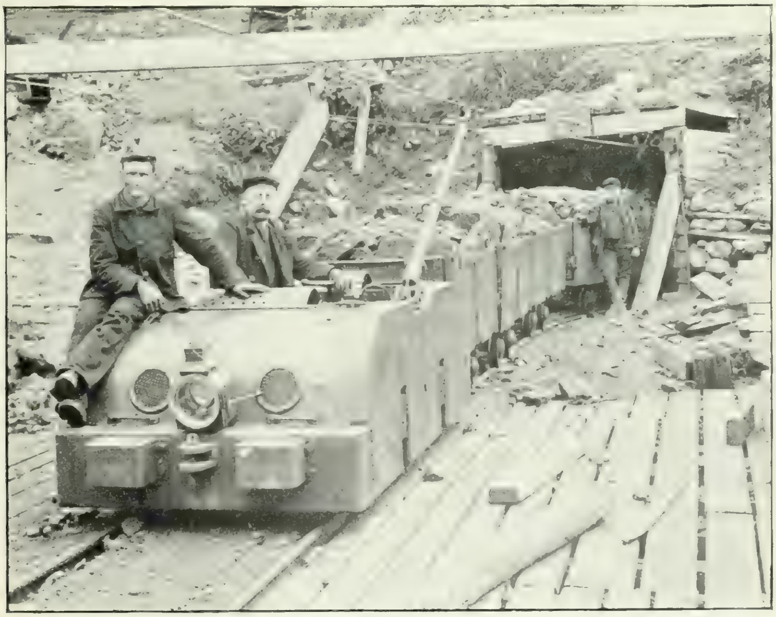
into the district acted as a great spur to industry, and in the last few months all the more developed mines have been suitably equipped with machinery. Previous to the construction of this railway, machinery and supplies were hauled in, a distance of 65 miles, over a rough mountainous waggon road, at the almost prohibitive charge of 2 to 3 cents per pound. While the conditions now existing are eminently more favourable, the future of the Boundary Creek district now rests largely with the metallurgist. Next year, however, should witness a very considerable output of both copper and gold from this region, and particularly of the former metal.

KNOB HILL AND IRONSIDES MINES, IN THE BOUNDARY CREEK DISTRICT.

In East Kootenay, with an exception in the case of two or three large producers of lead and silver, very little productive mining has taken place; but the effect of improved transportation facilities as afforded by recently constructed railways is here also becoming very apparent in greatly increased activity. Exceedingly promising "prospects" of copper, gold, silver and lead are now being developed in several localities included in this area, but by far the most important work in course of progress is the opening up of the vast coal areas of the Crow's Nest Pass—undoubtedly one of the largest coal properties known. The measures occur in the heart of the Rockies and extend north and south a distance of 40 miles, stretching east and west 10

SLOCAN STAR MINE CONCENTRATOR SANDON B. C.

miles from the banks of Elk River towards the boundary line between Alberta and British Columbia. This area is, of course, reduced by the creeks which abound on the mountain slopes, and from which the coal measures have been eroded, but sufficient remains to constitute the coal fields unique in extent, as they are in richness. The geological report states that there are upwards of fifty workable seams of coal,



ELECTRIC LOCOMOTIVE COMING OUT OF A BRITISH COLUMBIA MINE.
The coal cars carry a load of 2 tons gross each.

varying in thickness from 4 to 30 feet and of these about one-third are cannel and the remainder bituminous. The tonnage of coal contained in this field was computed some years ago by Dr. Selwyn, then associated with the Geological Survey of Canada, after making all necessary reductions, at 75,000,000,000 tons. No less remarkable is the exceptional quality of the coal, which when coked gives a product that has no superior, as the following comparative* table of analyses of the principal bituminous coals of the world, adequately shows:

Locality.	Country.	Volatile Matter.	Fixed Carbon.	Ash.	Total Fuel.
Pennsylvania	U. S. A.	29.50	64.40	6.10	93.90
Virginia.	"	33.68	57.76	8.56	91.44
Indiana	"	39.00	52.00	9.00	91.00
Illinois.	"	36.59	59.47	3.94	96.06
Iowa.	"	44.00	48.50	7.50	92.50
Missouri	"	34.06	50.81	15.13	84.87
Newcastle	England.	37.60	57.00	5.40	94.60
Staffordshire.	"	37.86	59.64	2.50	97.50
Derbyshire.	"	35.10	61.65	3.25	96.75
Yorkshire	"	35.67	62.08	2.25	97.75
North Wales	Wales	36.56	57.49	6.25	93.75
Pictou	Nova Scotia.	29.63	56.98	13.39	86.61
Sydney	Cape Breton	34.07	61.43	4.50	95.50

Crow's Nest Coal, taken on same basis as above.†

Locality.	Volatile Matter.	Fixed Carbon.	Ash.	Total Fuel.
No. 2 Tunnel—Coal Creek	21.02	76.25	2.73	97.27
" " "	25.00	72.50	2.50	97.50
Peter Seam—Martin's Creek	34.70	58.30	7.00	93.00
Jubilee Seam— "	31.70	68.30	4.20	95 80

The immediate result of the operation of the Crow's Nest collieries and the establishment of coke ovens was, as I have already pointed out, the cheapening of the cost of local smelting. Until this fuel became available, the price paid for Welsh coke at the Trail smelter was from $15 to $18 per ton, while an inferior coke containing at least 18 per cent. ash, made from the Wilkington, Washington, cretaceous coal, was also supplied to these works at a cost of $13.40. Owing to the natural advantageous location of the East Kootenay deposits for cheap and economical working, the plentiful supply of timber for all mining purposes, and the abundance of water in the streams of the

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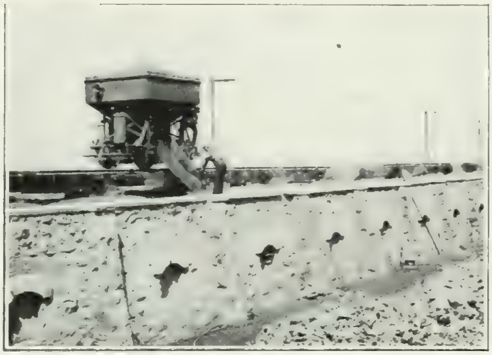
* From a paper read before Am. Inst. M. E., by W. Routledge, 1885.

† Minister of Mines' Report, 1898.

TOWN OF FERNIE, SHOWING COKE OVENS UNDER CONSTRUCTION AND COMPLETED

neighbourhood for power, the Crow's Nest Coal Company can produce "run of mine" coal for $1.25 per ton and sell and deliver coke to the smelters at $6, or less, per ton. At present the output is sufficient only to supply the local demand, but in a very short time the product of these collieries will find a ready market not only in the neighbour-

STREET SCENE IN GRAND FORKS, IN THE BOUNDARY CREEK DISTRICT.



ELECTRIC-DRIVEN 7 TON COAL LORRY, FOR CHARGING COKE OVENS AT FERNIE.

ing states, but Crow's Nest coal, it is understood, will also be purchased largely by the British Admiralty for use on the ships of the Royal Navy, so satisfactory have the tests proved.

There are other districts in addition to those to which I have made special reference, which, if they have not as yet contributed to the mineral production of British Columbia, promise ere long, on the strength of recent discoveries, to do so very appreciably. In short, there is no longer any question as to the exceedingly bright future in store for the mining industry of this country. Gradually the obstacles to progress which now appear so formidable will be overcome; the labour problem will present far fewer difficult points as the mining districts become more thickly populated and as the industry becomes more firmly established; mining and metallurgical costs will be still further reduced as conditions are more perfectly understood; and in proportion to the growth and importance the industry attains, so will be the readiness of capital, both British and American, to enlarge its scope in what must ultimately become one of the most important centres of mining activity in the whole of North America.

COKE OVENS OF THE CROW'S NEST PASS COLLIERIES, EAST KOOTENAY.

ELECTRICAL MEASUREMENTS OF WORK OR ENERGY.

By G. L. Addenbrooke.

IN making electric measurements it is not only that we measure electric quantities and actions, but that by means of measurements made electrically we are able to measure all sorts of other important things accurately.

For instance, measure the actions of a motor and its efficiency at different loads, and then set the motor to drive a lathe or some other tool or mechanical appliance. By watching and noting the readings of the electrical-measuring instruments we have at once an easy, accurate, and comprehensive method of observing exactly what the tool is doing under all circumstances and of the power required to drive it. We are, therefore, able to understand the working of that tool in a way which was not possible before, and not only are we in a position to see what is the most economical way of driving it, but how it can be used to the best advantage. It has never before been possible to investigate the working of the tools and other appliances by which man assists himself, in the way in which it can now be readily done by means of electric driving and measuring, by means of direct reading instruments, the current required to drive.

Again, the practice of testing engines coupled to dynamos—which, with proper arrangements, can be done continuously and with great accuracy and facility—has not only led in a few years to the production of dynamos of great efficiency, but it has enabled the output and working of steam and gas engines to be watched in a much more critical and detailed manner than has been possible before, and this has undoubtedly led to great mechanical improvements in steam engines, as well as to higher efficiency.

A working knowledge of the principles and method of making electrical measurements is, therefore, not useful merely in dealing with purely electric questions; by applying this knowledge intelligently we are enabled to watch, investigate, and control a great many other mechanical and industrial operations and chemical processes with great ease, and in a way which helps powerfully to secure the best results with the least expenditure in each case. Electrical measurement is also a ready means of testing the quality of many materials.

Further, electrical measurement in tramway and railway work has enabled the working of the whole of such systems to be investigated and observed in the greatest detail, and there is no doubt that the rapid adoption of electric methods for tramway work and the rapid development of electric traction has been due to the fact that, from the first, ready means of measuring and observing what went on when a car was running, both as regards the engines, the dynamos, the lines, and the cars themselves, has enabled the working of the whole system to be understood and kept under observation, and has pointed out the nature of faults and the right way to remedy them in a manner which nothing else could have done.

Also, owing to improvements in thermometers and pyrometers worked on electric principles, we have a ready means of recording, either instantaneously or continuously, temperatures over an immense range. By this method accurate measurements are easily made of the temperature in any parts of boiler flues or other furnaces and in gas and steam-engine cylinders, so that we are able to observe in an accurate and comprehensive manner all this class of actions, which have hitherto presented many points of obscurity. We might speak of electric measurements in connection with the telephone, but space fails us to enumerate all of the indirect uses to which electric measurements can be put.

We must not, however, pass on without remembering another field in which electric measurements are of the greatest value, viz.: the field of telegraphy, particularly submarine telegraphy; and it is the more important to mention this, because it was really to fulfil practical needs in these fields that the modern and extraordinarily accurate systems of electric measurement were first developed. It is well worthy of note that the methods of electric measurement which we now look on as fundamental have not been developed so much in laboratories or for pure scientific purposes as by commercial engineers and for direct commercial uses. Developed for practical purposes, they have reacted on laboratory work and helped enormously in purely scientific research.

For instance, when it was first attempted to construct submarine cables of any length it soon became apparent that it would be of great advantage to have a much more sensitive and superior method of testing their insulation while being made than any at the time available, and also that very sensitive instruments were necessary to act as signaling devices when the cable was in use. To meet this need Lord Kelvin (William Thomson), developed the reflecting galvanometer. The extraordinary sensibility, simplicity, and accuracy of this instrument not only effected what was required in connection with submarine work, but, at the same time, it enabled electrical measurements of several other kinds to be made with a remarkable degree of facility and accuracy.

Again, to measure the resistance of wires, which was important in commercial telegraphy, there was evolved what is called "the electrician's two-foot rule," namely, the Wheatstone bridge of Sir Charles Wheatstone. This is a means by which, preferably with the addition of a reflecting galvanometer, the electrical resistance of wires or bars of metal can be measured with extreme accuracy and facility. Then came the quadrant electrometer, an evolution from simpler forms, also one of the creations of Lord Kelvin—an instrument most useful for measuring the quality of insulating materials and which in improved forms will play a greater part in the future as an instrument for measuring alternating and multiphase currents than it has done in the past.

Lastly, should be mentioned the labours of the British Association Committee, who, in their endeavours to define and make an accurate standard of resistance for practical purposes, did much to improve and lay down the broad lines on which standard electric measurements should be conducted.

There have been also a host of other workers in these fields whose names will be found in the leading text books.

The purpose, however, of this article is not to relate history, but to say a few words on the principles of modern electric measurement to engineers and manufacturers or others who are not electric specialists themselves, but who are likely to come in contact with electric work or who might help themselves in their own business in some way by measurements made by electric means if they knew more about their scope and method.

The literature relating to electric measurements is exceedingly discursive, and facts and directions are scattered about in all sorts of places. This is due partly to the rapid advances continually made in the construction of instruments and in the methods of using them, and also, no doubt, to the very facts which have already been mentioned, namely: that measurements are made electrically for all sorts of purposes not directly electric, and therefore descriptions of methods of electric measurement and directions how to perform such measurements are found in connection with subjects not purely electrical.

It may consequently be asked: Are then, the methods by which electric measurements are made so very diverse? The answer is: No.

If once the principles on which electric measurements must be made are grasped, the methods are in principle both simple and few; but, at the same time, the varieties of instruments which have been designed for performing more or less similar functions in slightly different ways are numerous and rather confusing sometimes. For performing some of the more intricate kinds of measurement there may, however, be elaboration of detail.

The electric currents which it is necessary to measure in practice now are of two kinds—"continuous," that is, propagated continually in the same direction, and "alternating," that is, having the direction reversed continually. In telephony this reversal of directions occurs several hundred times a second, and often at a similar rate in modern telegraphy, while in electric-power work with alternating or multiphase currents the rate of change of direction is usually between thirty and fifty times a second.

Now the properties of alternating currents are in many ways different from those of continuous currents, except when the latter are starting or stopping, and therefore, although nearly all instruments which are used to measure alternating currents can be used also for continuous currents, it does not follow that instruments which can be used for continuous-current measurement are also adapted for measuring alternating currents. We shall therefore have to distinguish between instruments adapted to measure both classes of currents and those adapted for use with continuous currents only.

The modern view of electric currents is that electric energy is conveyed through the ether, chiefly in the neighbourhood of the wire, in a much greater measure than through the wire itself, the wire rather serving to define the direction in which the force will act than to carry it in the sense that water is conveyed in a pipe. It is important to bear this in mind in connection with electric instruments, because nearly all measuring instruments are based in principle on the utilisation of one or more of the actions which take place in the ether surrounding a wire when a current is being propagated along that wire, or on what was formerly called "action at a distance."

When an electric current flows in a wire it produces primarily two effects in the space surrounding it—the electrostatic effect and the electro-magnetic effect. The electrostatic effect is the same effect as that which you see if you tear up dry tissue paper in small bits and put it on the table and then rub a stick of sealing wax on your coat sleeve and afterwards hold it near the paper. The bits are sharply attracted and afterwards apparently repelled, though the repulsion is only apparent and can be explained another way. A set of very valuable measuring instruments, which are likely to come into greater commercial use in the future than in the past, are founded on this action by substituting a light aluminum needle for the paper, and metal "quadrants" held near the needle for the sealing wax. When an electric circuit is properly connected to such an instrument a difference of electrostatic pressure is set up between the needle and quadrants and the needle is attracted more or less, according to the strength of the electrostatic pressure, just as the bits of paper are. This motion is made visible by attaching a pointer to the aluminum needle, or, for more delicate work, by using a small mirror attached to the needle, which reflects a beam of light onto a scale. Lord Kelvin and others have made instruments of this kind which are largely used commercially, and I have been at work for some years on a set of instruments of this character which are intended to form a standard set for central stations for both alternating and continuous-current measurement. For it is one great advantage of most instruments based on this principle that they can be used for the measurement of either alternating or continuous currents, and their readings are correct for both without recalibration. Owing to the delicacy of their action instruments of this class are, however, used mostly by skilled men. They are for many purposes the best kind of instruments to use, if the skill and knowledge required to make use of them properly are available, but where this is not forthcoming and a rather lower standard of accuracy is sufficient, other classes of instruments have hitherto usually had the preference. Joubert and Mascart's and Dr. Hopkinson's classic work on alternating currents was, however, nearly all done with instruments of this type. At present, however, such instruments are used as standards for checking the calibration and working of other instruments rather than for purely commercial measurement, except in special cases.

The second effect which is produced in the neighbourhood of a wire when a current flows is the electro-magnetic effect—that is, the space around the wire becomes circularly magnetised. The magnetic field, as it is called, falls off in strength as we get further and further from the wire. Mechanical effects can be produced in several slightly different ways by taking advantage of this action. For instance, if we pass a current through two wires, one of which is fixed and the other is hung or balanced near the first, but in such a way that it can move, when a current flows in the same direction through both wires they are attracted to each other; and, if this attraction is balanced by a spring or a weight and the movable wire brought back so that it is just kept in its former position, the amount by which the spring is stretched or the size of the weight used can readily be made to measure the rate of flow of the current—or the "amperes," in electrical language. Instruments founded on this principle are called dynamometers and were invented by Weber. Siemens made a type in which a spring is used, which is very largely used commercially, particularly for alternating work, and Lord Kelvin has another type founded on the use of a weight, much used in England by manufacturers and in central stations as standard instruments. Though not as accurate as electrostatic instruments for alternating measurements, they answer for this class of work if proper precautions are used—in fact, it may be said that commercial alternating work has been almost entirely built up on observations made with instruments of this type. They are also largely used by electrical manufacturers in their test rooms for testing continuous-current plant as well as alternating; indeed, during the last twenty years they have been very intimately connected with electric progress. Their disadvantages are that they require manipulation in order to give a reading, and also need some skill in use. They are also rather troublesome to calibrate. They have one great advantage, which they possess in common with one type of electrostatic instruments; that is, that as they are double acting, one coil can be connected across a circuit with a high resistance in series while the other coil is inserted in the circuit. In this way the instrument can be made to read directly the watts, and thence the horse power, which is passing along a circuit; this is really what we want to know in many cases, and we thus get a reading which can be directly compared with an indicator diagram from an engine. Such an instrument will also measure directly the power taken by tools driven by a motor, or, in fact, any mechanical work done by an electric motor, and instruments of this class, whether founded on electrostatic or electro-magnetic principles, will undoubtedly come into much greater use. "Wattmeters," as they are called, are also instruments which are essential when dealing with alternating or multiphase currents, because with this class of current you cannot ascertain the power or the work which is being done by multiplying together the voltmeter reading of the pressure and the ammeter reading of the current, which can be done when the currents used are continuous. In the case of alternating currents, in addition to the current required for the work to be done there is the current needed to create the magnetic field in the ether surrounding the conductor and in any iron which it encircles, which magnetic field is necessary for the propagation of the current. Consequently there is nearly always what is called a "lag" in alternating circuits, especially when driving motors, and if the current as shown by an ammeter is multiplied by the volts as shown by a voltmeter the result gives a figure for the watts or horse power which is in excess of what the power expended really is, so that this figure has been christened the "apparent watts." To get the true power we must use a wattmeter which has the interesting property of being able to disregard the part of the current which is not doing actual work and to measure only what is called "the effective component" of the current, or the working part of it. The perfect way this is done by an extraordinarily simple contrivance is one of the pretty things of physics, and one of the instances in nature where it looks at first sight as if there was a tangle which nothing would unravel and then, by some unlooked-for and simple expedient, the whole complication is completely resolved and can be dealt with in detail. To explain this intelligibly, though extremely interesting, would be to go too far into electrotechnics in this article, so we must pass on to other classes of instruments.

At two currents attract each other by means of their electro-magnetic action, so it follows that if a piece of soft iron is put near a current it is attracted to the strongest part of the electro-magnetic field, just as a piece of soft iron is attracted by a magnet, and this action can be intensified by making the conductor into a coil and putting the soft iron inside. Instruments so made can be used on either continuous or alterating circuits, but for continuous currents the current must only be passed one way, and for alternating circuits the instrument must be standardised for the particular frequency or rate of reversal of the circuit. Such instruments are not very accurate, but sufficiently so for many commercial purposes, and vast quantities are daily turned out for fixing to switch boards. Formed with a coil of a few turns and inserted in a circuit, they form ammeters or current measurers, and wound with a high resistance of many turns and put across the circuit, by calibration they are made to read by inference from the current passing the volts or electric pressure between the conductors of the circuit. They are apt to vary their readings after being in use for some time and also when they get hot, but as they are very cheaply made and stand some knocking about they have in the past met with much favour.

Where a little more can be paid for an instrument of higher accuracy there is another type which is rapidly coming into favour.

Unfortunately it will only measure continuous currents. Just as two currents act on each other by virtue of the attraction of the electro-magnetic fields they set up, and a current will attract a piece of soft iron, so the electro-magnetic field of a current will attract a magnet itself, the action being such as to cause the magnet, if movable, to tend to stand at right angles to the direction of the current. Consequently if we take a compass needle it will tend to be set north and south owing to the earth's magnetic field, but if we pass a current from north to south along a wire near the needle the needle would tend to be set east and west by this current, and the two forces each pulling according to their strength, the needle stands more or less diagonally and the angle of its movement from rest can be made to measure the strength of the current. Also the action of the current can be intensified by coiling the wire carrying the current round and round, over and under the needle in the same direction. In this way is made the instrument every electrical workman carries, called the "linesman's detector." In this way also is made the reflecting galvanometer already referred to and a number of other instruments.

Instruments of this class are very nice and very accurate as long as we have to deal only with the earth's field and the current to be measured, but they are troublesome and uncertain when used near moving masses of machinery or where other currents may be passing near. They have lately, therefore, been largely supplanted by what is called "the D'Arsonval, or moving coil" type of instruments. These instruments are founded on the same principle as those just described, but the action is reversed; instead of the magnet being small and moving and the coil remaining fixed, the magnet is large and fixed and the coil is small and hung between the poles of the magnet. The magnetic field is so strong and constant in this case that the instrument is not affected by the earth's field or moving iron masses near, and the instrument can easily be made to have the important property of being nearly dead beat. Weston in America has done much to improve and introduce this type of instrument, and other makers in England and on the Continent have followed his lead. The instrument, by the use of shunts or by a high-resistance winding, can be made to measure either electric pressure or "volts," or current as "amperes," provided the current is continuous. For manufacturers and others who want to make reliable electric measurements of power in the form of continuous currents in their business, but do not want to go into detail or cannot afford to keep a skilled electrician, this type of instrument is undoubtedly the most reliable and the easiest to use. Many thousands are in use on central-station switch boards for lighting and tramway work.

We have now exhausted the types of instruments based on actions occurring in the ether or space surrounding a current, but before concluding we must notice another class of instruments which are very largely used in alternating and multiphase work and which can also be used with continuous currents. They are not founded on actions taking place outside the wire, but in the wire itself. When a current flows along a wire the wire becomes heated, and when heated most metals expand. Advantage is taken of this action in two different ways. In the first, a long, fine wire is mounted so that one end is fixed and the other free. When a current passes the wire stretches, and its elongation is measured on a dial by an apparatus something like that in an aneroid barometer. This is known as the Cardew voltmeter. In another form a short wire is stretched between two supports and the middle is attached to a light spring pulling at right angles; if the wire is heated a considerable movement of the spring occurs for a slight expansion of the wire, which is communicated to a pointer as before. Instruments of this class are not scientifically accurate, but except for the current wasted in them they make good switch-board instruments and are used in very great numbers, particularly on the continent of Europe for multiphase power work.

This completes the list of actions on which leading types of electrical measuring instruments are founded.

To make electrical-power measurements it is often sufficient to possess only voltmeters and ammeters, or perhaps wattmeters of suitable range. Unless, however, the measurements required are all of one class and within a limited and well-defined range, we must either go to considerable expense in buying instruments covering a great range, or adopt some expedient to increase the range of those instruments we have. It is in the use and adoption of such expedients that the skill of the technical electrician is needed. In a great many cases the deflections of the instruments go as the square of the currents or electric pressures dealt with. It is difficult in such cases to make one instrument have more than a three- or fourfold range—say to read between 1 ampere and 4 amperes, or from 100 volts to 400 volts. Consequently to secure accuracy and a large range, say 1 to 1,000 or more, we should need a number of instruments of each sort, the changing from one to another of which would be inconvenient, besides the expense involved. To get over these difficulties much measurement work is done by the help of "shunts," by the use of which only some known part of the current or electric pressure is measured. By the employment of these an instrument can often be made to measure currents or electric pressures accurately over a range of a thousandfold or even more, if the instruments are of a sensitive type, such as reflecting instruments. It would, however, unduly extend this article to go into these technicalities.

When once the principles are grasped the measurement of electric currents or electric energy within certain ranges such as are often used in a single trade is an easy matter, and if the apparatus is set up by a skilled man and occasionally looked over, an observer with very little knowledge can make all the observations which are required in the daily round of business.

In undertaking electric measurement it necessarily follows also that we get a clear insight into and a working knowledge of all other electric actions, such as those which take place in dynamos and motors, and from this standpoint the laws and methods of their construction and use can easily be understood and grasped.

Although we have no special organ which enables us to touch, see, or feel most electric actions, it is a curious fact that within the last half century methods of electric measurement have been perfected which enable us to indicate clearly all that is going on with as great accuracy, if necessary, as is attained by the chemical analyst in his laboratory who can weight to one one-thousandth of a grain. In fact, just as we can make a series of balances which will weigh anything from less than one one-thousandth of a grain to 50 or 100 tons, so we can make a series of electric instruments which will measure accurately from one one-millionth of a volt or ampere or less to 10,000 or 100,000 amperes or volts or watts or more, and by the intelligent use of shunts one set of suitable instruments may be made to include nearly if not all this range.

It has been said that "Science is measurement." The electrician or electrical manufacturer or station superintendent therefore, if he avails himself of the resources at his disposal, is in a position to conduct his business on very scientific lines and to ascertain very exactly all that he is doing. He has thus exceptional opportunities for advancing surely and avoiding mistakes and faults, while many other trades may usefully avail themselves of electric measurements to inform themselves exactly as to the working and action of the apparatus or plant they turn out or the power they use, and so can obtain the most economical and desirable results.

THE IRON SITUATION FROM A BRITISH POINT OF VIEW.

By J. Stephen Jeans.

VERY little more than a year ago, I was present at a meeting of the Civil Engineers in London, at which my deceased friend, Mr. Jeremiah Head, and his son, Mr. A. Potter Head, submitted a joint paper on the Lake Superior iron-ore mines. In that paper it was stated that the approximate cost of producing a ton of Bessemer pig iron in Middlesbrough, the chief centre of the iron trade of Great Britain, was £2.12.2, whereas in Pittsburgh (U. S. A.) it was not more than £1.12.5½. The selling prices of ship-plates were at the same time said to be lower in Pittsburgh than in Middlesbrough by 24s. 3d. per ton; of steel billets and blooms, by 22s. 6d. per ton; and of heavy steel rails by 9s. 9d. per ton.

Since that time many things have happened. The prices of pig iron, steel plates, billets, blooms, rails, and wire rods, have advanced about 100 per cent., and in some cases by 150 per cent., not only in the United States, but in more than one European country as well. The prices of raw material have advanced in a more than corresponding degree. On the Tees, coke for blast furnace use has gone up from 14s. to 26s. per ton, Spanish hematite ore has gone up from 13s. to 21s. 6d. No. 3 Cleveland pig iron, which has been sold in some previous years as low as 29s., has gone up to nearly 80s. per ton, and so, *mutatis mutandis,* with most of the other products of our mills and forges. In the United States, the advance of prices has been even greater than in Great Britain, and in some continental countries it has been more considerable than in either Great Britain or the United States.

The developments of the past sixty days make it plainly evident that the high prices still ruling in the iron and steel markets stand as a menace to the prosperity which the engineering industries throughout the world have been enjoying for several years past. We are especially pleased, therefore, at being able to present this timely, conservative, and well-informed paper from the pen of the distinguished Secretary of the British Iron-Trade Association. That the price of pig iron is the barometer of trade has become an accepted truism. And rarely indeed do we have the opportunity to see the essential facts of the iron-trade situation throughout the world stated so calmly and so clearly, at a time when all eyes are watching the quotations for iron and steel, and when thoughtful men throughout every branch of the engineering indus-

At the present writing we appear to be at the parting of the ways. The boom is not absolutely spent, but it has exhausted a great deal of its force, and there are many evidences that the near future will be likely to bring with it considerable changes—perhaps changes that will be as surprising as those that have already been named. Very few foreign orders have been booked in Great Britain during the last week or two, which is an indication that foreigners are waiting for lower prices. The British ship-building trade is much less brisk than it was, and not many new orders are coming to hand. American manufacturers are giving greater attention to their foreign customers, or hoped-for customers, and have lately been quoting plates and bars, delivered in Australia, for about the prices that are being quoted in England at

tries seem to be waiting for that concession in prices which will make possible the onward march of constructive enterprises. Mr. Jeans tells us that within a year the prices of iron and steel products have been more than doubled in every market of the world. He might have added, also, that the prices of iron ore, notably in the Lake Superior region, have also been more than doubled within the same period; and among both British and American coal-mining companies every effort has been made to force up the price of both coal and coke. The logical and necessary effect has been a practical check to orders for new business, not alone in the ship-building industry, in railway construction and improvement, and in building operations, but wherever iron and steel figure in the cost of construction—which means practically everywhere. But Mr. Jeans shows us also that the normal increase in consumption of iron will undoubtedly employ the world's productive capacity if there be no halt in constructive and manufacturing enterprises. He might have added that the sure promise of early and unprecedented development in South Africa, in China, in Russian Asia, in Australia—indeed, throughout the world—makes certain a long era of uniform and uninterrupted activity in all branches of the iron and steel trades. But in the face of these conditions, reports from every quarter of the world tell of halting industry, orders withheld, factories and works closing down, and widespread waiting for the necessary and inevitable decline in the market prices for iron and steel. Surely if ever the managers of the great consolidations and combinations had an opportunity to show wisdom and foresight in vindicating the arguments which have been used to justify their formation, they have it now. The obvious demand of the hour is for a *radical* reduction in prices, which will meet the markets, insure orders enough to keep iron and steel works steadily busy, and thus renew the forward movement of this remarkable industrial era. And it must not be supposed that the policy of gradual reductions can meet the situation. The evils born of a sudden advance in prices ranging from 100 to 150 per cent. cannot be cured by conceding an occasional 10 per cent. That would be like cutting the dog's tail off an inch at a time—not only painful, but certainly perilous. For each forced reduction serves only to whet the anticipation of its certain successor, and in the end values are forced below the normal range. —THE EDITOR.

works. Similar indications might be multiplied, but that appears to be needless. The problem now presented for solution is whether these evidences mean merely a passing lull, or whether they point to a world-wide repletion, which is likely before long to develop into a general glut. There is probably no maker of iron or steel throughout the world who would not give much for an inspired reply to this question.

There is no gainsaying the fact that the iron and steel manufacturers of Europe are beginning to look with anxious eyes to the United States. It seems to those who think they can discern the coming events casting their shadows before that the sword of Damocles is suspended over the heads of those who are now enjoying a feast of fat things. That sword is the near competition of the United States. It is, moreover, a two-handed sword, for it cuts to the very dividing asunder of joints and marrow by an admitted capacity to produce more cheaply than European countries, and it also presents the very formidable aspect of threatening to dump a vast surplus on neutral markets, on terms that are not competitive at all. To be perfectly candid, this latter is the form of competition of which the people of Europe are most afraid, because they are most powerless to resist it, and this remark, of course, applies more especially to Great Britain, which is a free-trade country.

It should, I think, be specially emphasised that British ironmasters do not stand in fear of the United States because of their admitted inability to compete with American manufacturers, but because they live under a different economic system and one which does not allow them to arrange for the regulation of prices to home consumers, in order that they may export, at any price they can get, a large surplus product. This is done both in the United States and in Germany, owing to the system of protection which guarantees to the manufacturers of those countries a virtual monopoly of their own markets. Many of my friends in the iron trade here have told me again and again that they would not fear the rivalry of any country under equal conditions; but when one country offers free markets and an open door, and others shut the door with a bang, the conditions are not equal, but very much the reverse. This is the greatest source of discouragement to the British manufacturers to-day.

Nevertheless, there is an obvious limit to the length that a manufacturer can go in dumping this surplus on foreign markets. Every European nation and most other nations, excepting Great Britain and the Scandinavian countries, have protective tariffs, which may be raised when American products become too strongly competitive.

Great Britain is likely to remain free. It would require little short of an earthquake to move the people of this country from the rock of free trade, to which they have anchored their economic barque. So far, therefore, as England is concerned, Americans have her markets at their feet if they are strong enough to occupy them. If they occupy them too much there may by and by be some sort of reprisal in the form of countervailing duties. On the other hand the competition of the United States up to the present time has not hindered, but has rather helped, the British iron trade by aiding it to execute orders that it was more or less unable to overtake, and by supplying much-needed raw materials for the wire, hoop, tin-plate, sheet, and other industries.

The development of the system of combinations or so-called consolidations of great manufacturing establishments must in the near future exercise a much more potent influence on the competitive conditions of the United States, in relation to Europe, than hitherto. Practically, it comes to this—that the control of the great iron and steel industries of the United States is not now vested, as it was up to a recent date, in the hands of many different firms who often had very little in common, but it is subject to the caprice and the controlling operations of half-a-dozen powerful corporations whose fusion, or united action, would virtually create a monopoly market and establish monopoly prices within the limits of the United States. There would appear to be no adequate reason why the prices of commodities, so far as they are controlled by these corporations, should not be raised to the utmost figure that the tariff will allow, and that may roughly be taken as 40 per cent. of the declared value of the products in American ports, which would mean at least 50 per cent. more than the prices quoted in Europe by European manufacturers.

When we look back on the experience of the past we find that the world's demands for iron have been so steadily progressive that it is impossible to doubt that they will continue so in the future. There are no substitutes for iron, nor are any likely to be found. All anticipations that the demand for iron would fall away have, in the long run, been falsified by results. Twenty years ago it was believed that the Bessemer process, which was estimated to yield a metal six or seven times more durable than iron, would practically ruin the iron trade, by the limitations it would be certain to impose upon the quantity of metal required for permanent-way renewals; and yet more material is used to-day for that purpose than has ever before been called for. Many similar examples could be quoted. At one period it is iron for railways, at another steel for steamships, at another for machinery, at a fourth it is the electrical field that is opened up to the ironmakers, and yet again, the consumption of iron is greatly stimulated by the increased use of both iron and steel in buildings, in rolling stock, and in a hundred other directions. Now, in estimating the wants of the future, it is important to remember that all these demands are cumulative, and that any particular source of consumption, once opened up, is not ephemeral, but has come to stay. This surely means that every succeeding period will show a great increase of consumption.

So far as can be ascertained at present the total increase of production of pig iron in 1899 over 1898 was about 4,000,000 tons, of which 3,848,926 tons were contributed by the countries named in the following table:

MAKE OF PIG IRON IN THE LEADING IRON-MAKING COUNTRIES, 1898 AND 1899.

Country.	1898. Tons.	1899. Tons.	Increase. Tons.
Great Britain	8,681,071	9,305,319	624,248
United States	11,773,934	13,620,703	1,846,769
Germany	7,288,343	8,117,594	829,251
France	2,525,075	2,567,388	42,313
Russia	2,221,709	2,671,624	449,915
Belgium	979,755	1,036,185	56,430
Totals	33,469,887	37,318,813	3,848,926

The wonderful place which the United States holds in this table is its most striking feature. Equally remarkable is the record of the steel industry of the United States for 1899, reaching, as it does, to more than 10,000,000 of tons. The comparatively slow progress made by other countries suggests that the United States, Great Britain, and Germany will mainly supply the world's wants in the future, or, at least, in the near future, and they may find they have quite enough to do.

For it is possible, after all, that competition, in the ordinary sense, will be unknown in the near future. It may easily be that there will be an absolute scarcity of materials—that it will take the utmost efforts of which all iron-making countries are capable, for many years to come, to supply the material and legitimate demands of the world, and that more countries, if any there be, that come to our aid may be regarded as the kindest of friends rather than as industrial enemies.

A good deal of anxiety has been felt during the last two years as to the available supplies of iron ores and fuel. The total world's consumption of iron ores in 1899 was probably more than 90,000,000 tons. Of this quantity, I take it that the United States contributed more than 22,000,000. But in all countries alike very exceptional efforts were made to increase the output so as to overtake the greatly stimulated demand. These efforts are still being continued. Spain has been ransacked from one end to the other, in order to increase the available supplies. France is opening up new sources of supply in Greece, North Africa and elsewhere. The Germans have sought to acquire almost a monopoly of the supply of Swedish Lapland—within the Arctic circle—for a number of years to come, and have concluded arrangements which point to their belief that iron ores are likely to become increasingly scarce. This is a very general apprehension, and if, as I believe, it is justified by the facts, then it seems to be probable that this condition may mainly determine future supremacy. Madame de Stael once observed that "Providence fights on the side of the biggest battalions." In the war of commerce and industry, it is conceivable that Providence may in the future seem to interpose on behalf of the nation that has the largest available supplies of cheap iron ores.

I shall have written this short article to little purpose if I have not succeeded in making clear my conclusions that the iron consumption of the world must continue to grow, and that, in all probability, at an increasingly rapid rate; that there must, nevertheless, be ups and downs, which will afford opportunities to enterprising countries, which, like the United States, are liberally endowed with natural resources; that we must be prepared for any sort of surprises in the future, as the past has proved the special liability of the iron trade to radical changes of prices and competitive conditions; that national economic systems are the most potent factors in facilitating or retarding successful rivalry, and that the difficulty most to be feared in the future is that of finding adequate supplies of cheap and suitable iron ores.

EDITORIAL COMMENT

History is making so fast in China that it is impossible to foresee the outcome of even the few days between the printing of these pages and their appearance in completed form. Correspondence from the empire, dated barely four weeks ago, made no mention of anything unusual, or, at most, contained only casual mention of "disturbances in the north, not likely to spread to any serious extent." Now the condition grows in gravity day by day, and properly takes first place in public interest.

Gen. Wm. Barclay Parsons' striking article upon the engineering development of China, which leads this number, is based, of course, upon the assumption that a stable and reasonably enlightened government is to exist in the country. So long as disorder reigns, so long especially as the reactionary forces are violent, enterprise and capital will stand aloof. But that these conditions will long prevail cannot be believed for a moment, and the indications are strong that out of present events will spring some very definite and radical change in the political administration of the empire. This is the conviction expressed by General Parsons in a most interesting interview upon which these paragraphs are based. His intimate acquaintance with Chinese affairs makes his opinion significant.

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It is highly unlikely, General Parsons thinks, that the present disturbances will end, as did the Empress's *coup d'état* of two years ago, in a mere party shifting of goverment At that time the crisis was brought on by over zeal of the reform element, in whose hands the Emperor was a tool, serviceable for his vested authority, but personally a nonentity. The rapid succession of progressive edicts —extending even to one ordering the cutting off of the queue—outpaced the advance of the people. The Empress Dowager, working with the reactionary party, was marked by the reformers for arrest, and the Emperor's order therefor was placed with the military governor of Pekin for execution. He, seeing more chance of personal profit in trading on his orders than in executing them, informed the advisers of the Empress. She returned hastily to Pekin, made terms with the general by which he swung the army to her support, and the first canto ended with the turning of the tables, the removal of the weakling Emperor, and the beheading, flight, or departure into exile of the reform leaders.

But the reacting wave of conservatism, in turn, seems to have raced too far and to be tumbling to destruction. Europe and America, tolerant of China's administration of her own politics, have been roused to needed action by disorders which the government could not or would not quell, and by anti-foreign demonstrations and outrages on the life and property of Caucasians which China was unable or unwilling to check. How far any particular foreign influence may have instigated the Boxer uprising, or may affect the attitude of the Chinese authorities toward it, is a question lying too deep down in the fascinating but tangled foreign politics of China to be guessed at now. It is certain that whatever influence Russia may have in China is with the conservative party, and and that the progressive party is Russophobe. The r port that the Empress has taken refuge in the Russian Embassy is disturbingly suggestive But is is not clear what Russia would gain by forcing a crisis yet When her plans for Eastern

Siberia and her Trans-Asian railway are completed, it may be different

But while it may be forcing an interpretation to see any evidence of an *entente* in the Empress's asylum under the Russian flag, her flight suggests the immediate fall of the existing government, and in its stead—what? General Parsons sees two possible endings of the affair, with no present indication strong enough to determine which will be brought about.

The first is the preservation of the integrity of the empire under joint control, the establishment of a stable Chinese government, of course by the progressive party, backed, supported (and probably largely inspired) by the Powers. The second is the dismemberment of China, with a general scramble for coveted territory, and very possibly a resultant war between Russia and Japan, or, indeed, a European war. That either solution has enormous difficulties needs no explanation. The situation is is one of tense, and even painful, interest.

* * *

In case of the partition of China, Russia would naturally claim the north and northwest; Germany would consider Shan Tung her share; England would seek the Yang Tse valley; France, Ton King and the south; Japan, the coast territory on the Eastern Sea; the fragments left over would be for the rest.

England has, of course, much to lose and nothing to gain from such a contingency. In pursuit of her fixed policy, she would "open the door" even to nations which would close their doors to her. The United States would be in even worse case, as they would not have even a "sphere of influence." Japan might gain some military advantage at the expense of commercial opportunity, and even the strategic gain would be more than counterbalanced by Russia's establishment. For Germany, advantage and disadvantage would be on a nearly even balance. It is probable a wise policy should place her with England, America, and Japan in a firm and positive stand for the integrity of China, a stable and strongly supported national government, and the "open door" throughout the empire.

France's interests are not large enough to give her an intense interest in the struggle; she could afford to take her chances. But Russia represents the other side; her interests, at all events as she sees them, demand her exclusive control of the territory which she covets It remains to be seen whether England, America, Germany, and Japan, standing together, can carry the day. It remains to be seen, also, if the Anglo-Saxon nations, by wisdom and calmness, can avert the danger of a Russo-Japanese war, which many authorities consider so near.

* * *

The problem is full of new quantities which cannot yet be estimated. One is the United States, suddenly stirred by over-sea interests, and with large military forces soon to be freed from service in the Philippines. Another is Japan, feverishly interested in her new economic expansion and her new navy, sharply jealous of Russia smarting under the diplomatic defeat which lost her Port Arthur, and under the Korean concessions. A third is the reported rottenness of the Russian organisation, military as well as civil, which some excellent judges believe would cause her to break down under the strain of war, and beyond doubt would give the victory to Japan. A fourth, and possibly the determining one, is the seasoned armies of England, as yet engaged in South Africa, but in all probability soon to be freed for work elsewhere.

In our own opinion, the most active danger is that Japan will break out of bounds to have a dash at Russia, but that if this can be averted Europe and America will come to an agreement by which at least nominal autonomy for China will be preserved—for the present. It is a new "Eastern question," but the sick man of Asia may live as long as the sick man of Europe, without actually bringing his prospective heirs to blows over his death bed.

REVIEW OF THE BRITISH PRESS

The Status of the Naval Engineer.

WAR is becoming more and more a matter of engineering science. That this is a fact is being generally recognised by the great body of civilians who furnish the means by which armies and navies are created and maintained, and who look to those armies and navies to protect and aid them. At the same time there is great reluctance on the part of those branches of the service not devoted to engineering to admit the engineer to the rank and authority to which the changed conditions have brought him. This is especially the case in the navy, and the present state of affairs in the Royal Navy with regard to the engineers is well shown in the important paper recently read before the North-East Coast Institution by the vice-president, Mr. D. B. Morison.

In this paper the importance of the engineer as a factor in the predominance of British sea power, so essential to the existence of the empire, is set forth in unmistakeable terms.

"The strategical, tactical, and combatative powers and functions of a ship of war are conceived, defined, and executed by the administrative and executive officers of the Royal Navy, but the responsibility for its creation, in the constructional sense in accordance with the stipulated requirements, and for its ability during its active life to respond readily and effectively to the directing will of its commander, may be correctly said to devolve upon the engineering profession.

"It is the engineer who designs and constructs the entire machinery of a warship. It is the engineer who is responsible for the generation of the all-essential steam, and for the vast aggregation of complicated machinery for its varied utilisation, and again it is the engineer who is responsible for the maintenance of the mechanism of the entire armament in a state of efficiency."

The growing importance of the engineer department with relation to the executive department is well seen when it is understood that in 1878 the total personnel of the engineering department was one-fifth that of the executive, while in 1898 it had increased until it formed one-half as much as the executive department. This is only what might have been expected from even a superficial examination of the increased adoption of mechanical appliances in naval warfare, but notwithstanding this great and natural increase the engineer department has had no extension of its powers.

"In spite of its undoubted importance, and the fact that it comprises approximately one-third of the total personnel of the navy, the engineering branch is not represented upon the Board of Admiralty, which is composed entirely of political and naval executive officers. Therefore, the engineer-in-chief, who is the responsible head of the department, is placed in a weak and subordinate position, which checks the full and free exercise of his experienced judgment in conformity with what he believes to be necessary for the attainment of the highest possible state of efficiency, throughout the one primarily essential department of the steam navy."

After touching upon the advanced requirements made upon the naval engineer in the course of the development of the steam navy, and showing the high degree of educational attainments now included in the training, Mr. Morison goes on to show how important are the duties and how great the responsibilities of the naval engineer.

An important point to be noted is the fact that the number of engineer officers is by no means adequate for the correct and complete fulfilment of the multifarious duties to be performed. This is readily seen by a comparison between the navy and the merchant marine. Comparing H. M. S. "Terrible" with several Atlantic liners of similar size and power, it appears that this, one of the greatest battleships of the navy, carries 1 fleet engineer, 5 assistant engineers, and 1 artificer engineer, added to which are 18 engine-room artificers, a total of 25 in all; but the artificers, although mechanics, carry no direct responsibilities. As neither the chief nor his principal assistant can take regular watches, this leaves but 6 engineers available to stand watch.

The "Lucania" carries 22 engineers, of which 10 hold first-class, and 3 second-class Board of Trade certificates, besides 2 electricians, 1 boilermaker and 24 greasers, in addition to firemen, trimmers, storekeepers, and donkeymen. There are 7 engineers on each watch. These proportions hold good throughout both services. On ships of the Royal Navy the ratio of engineers to men ranges from 1 to 21 in battleships, to 1 in 37 in ships of the "Terrible" class, and rises as high as 1 to 48 in some destroyers. In the merchant marine the ratio of engineers to men is about 1 to 8.

The present position of the engineers is most ill-suited to their relative importance, being included in the civil branch of the service, the whole of which is subordinate to the executive or military branch, and the officers of which receive no military rank or title and are not empowered to award punishment to their departmental subordinates for any offence whatever. Apart from the humiliating position in which this places the men upon whom the navy must depend for its efficient action, it conduces to undermine their authority in a way which may be hereafter realised only after bitter experience.

The engineer is no longer a non-combatant, and the title "fighting engineer," appropriately applied to the same branch of the service in the United States Navy, is equally fitting in the Royal Navy.

America now gives positive rank to her naval engineers, and under the new personnel bill will soon have done away with the anomalous condition due to the old state of affairs, and it is to be hoped that Mr. Morison's paper will arouse an agitation which will cause a like change to be made in the Royal Navy, without the necessity of a sharper lesson to those in power.

Distant Electric-Power Transmission.

THE recent paper of Professor George Forbes, presented before the Institution of Electrical Engineers, contains much of interest, in view of the prominent part which the author has taken in the development of long-distance transmission work.

The first portion of Professor Forbes's paper relates mainly to a condensed account of some of the leading plants in various parts of the world, including those at San Bernardino, California; Snoqualmie Falls, Washington; Padermo, Italy, and Rheinfelden, in Germany. In addition to these Professor Forbes gives an account of the general arrangement of the plant at Niagara Falls, for which he assumes the main responsibility, and for which he shows great practical success. The great point which has been demonstrated by the generators at Niagara is the success of the low frequency there adopted, and, in general, the great dimensions of the plant.

The author touches on the transmission to Buffalo, discussing the manner in which, by the use of Mr. Scott's device, the current is changed from two-phase to three-phase, and speaks with especial commendation of the ingenious automatic cut-outs, which have been of such high value in preventing interruptions of supply on the Buffalo transmission.

An interesting feature in this connection is found in the question of the regulation of the turbines. The first three turbines were regulated by a purely mechanical governor, but the later ones were provided with a more sensitive mechanical governor. It has been found in practice that the supply at Buffalo is most steady when the two turbines driving the dynamos are regulated, one by a sensitive and the other by a coarser governor.

Passing from the consideration of individual plants, Professor Forbes proceeds to discuss the questions of Lord Kelvin's law of economy, to the use of boosters and phase rectifiers, to the relative merits of different kinds of polyphase systems, to overhead and underground conductors, and to the use of aluminum.

In regard to the application of Kelvin's law, the data on which we choose the current density by this law depends on (1) price of copper; (2) price per annum of the horse power; (3) interest on the price of copper. In this connection the following meanings of (2) and (3) may be noted. When using water power which is unlimited compared with the demand, (2) is the price per annum of generating the power. When the water power is limited and the demand unlimited, (2) is the selling price of the power. If the copper be mortgaged, (3) is the interest paid on the mortgage, say 4 per cent. If the copper is paid for out of capital, (3) is the interest to be paid in dividends on the capital, say 15 per cent.

Kelvin's law was originally announced as being true only when the percentage drop in volts was small. By using boosters along the line the drop in volts can be corrected, as Professor Forbes shows by an example. In the original paper tables are given showing the results with and without boosters when the line is considered as a whole, or is divided into two, three, and four sections; together with corrections for capacity, self-induction, temperature, and sag.

By the use of boosters it is possible to reduce the weight of copper in some cases to less than one-half of what was possible by the old system; a very important feature when power is cheap and the distance of transmission great.

Passing briefly over the questions of induction factors and phase rectifiers, choice of polyphase systems, and material and character of conductors, Professor Forbes proceeds to make some suggestions as to a British type of power transmission, differing somewhat from what appears to be becoming the normal arrangement.

There appears to be a tendency at present to crystallise plans and to settle into grooves which do not always seem to be the best. Tenders from various firms for the same installations resemble each other very closely, except as to details. Three-phase currents generated at 2,000 to 3,000 volts are used, with frequencies from 25 to 40. Separate turbines for the exciters, with the main turbines and generators on horizontal shafts, are the rule. The transmission pressure varies between 24,000 to 30,000 volts, and two complete and independent sets of conductors are employed.

Professor Forbes suggests that the arrangement which suits a transmission line which is also a distributer of power does not necessarily yield the best results for a plant transmitting the whole power to a long distance; that the high-pressure continuous-current system is very suitable for certain cases; that the two-phase alternating current is to be preferred over the three-phase in many cases, and, that the horizontal shaft for turbine and dynamo might well be replaced by a vertical shaft, as at Niagara, Rheinfelden and elsewhere. Manufacturers and contractors in Great Britain have not given the subject of long-distance transmission plants sufficient attention, and they run a risk of being passed over entirely in the future as they have been in the past, unless they put themselves in readiness to undertake such work. Although there are but few great water powers in Great Britain, immediate progress may be expected in connection with the development of power at the coal pits. If this is done a large share of the field in the colonies, where water-power is available, may be acquired, and British manufacturers secure a position in this important and growing trade which until the present has been almost entirely in the hands of other countries.

Gas-Driven Blowing Engines.

Among the papers presented at the recent meeting of the Iron and Steel Institute was an interesting one by M. Adolphe Greiner describing the construction and performance of a large gas-driven blowing engine at the Cockerill works at Seraing, Belgium. This is the first blowing engine worked by blast-furnace gas ever employed in any iron works, and hence the account was received with great interest.

Blast furnace gases have been the subject of animated discussion for several years, but until recently the trials have been made with only small engines, the effort being rather to demonstrate the suitability of the gases for direct use, than to install a working plant. About two years ago the Cockerill establishment started a 200 horse-power gas engine, using furnace gas, and driving a dynamo for lighting purposes, and this engine has been working satisfactorily day and night ever since.

The new blowing engine is of much

larger capacity, having been designed for 600 horse power, and this power has been considerably exceeded in actual service. The dimensions of the engine are necessarily large, the gas cylinder being 4 ft. 3 in. in diameter, and the air cylinder 5 ft. 7 in. in diameter, both being 4 ft. 7 in. stroke, 80 revolutions per minute.

This engine has been running since November, 1899, and it has recently been the subject of a series of very precise experiments to determine the consumption of fuel, as well as the useful effect of the blowing engine. The tests were conducted by M. Hubert, of the Liége School of Mines, in the presence of M. Witz, Mr. Bryan Donkin, Professors Meyer, of Göttingen, Dwelshauvers, of Liége, and others.

The general details of the trials are given in M. Greiner's paper, from which it appears that a most excellent thermal efficiency was obtained. The gas was tested by two methods, the calorimetric bomb tests of Professor Witz giving a mean calorific power of 984 calories per cubic metre, while the Junker calorimeter showed a mean value of 860 calories.

The engine was first tested simply as a gas motor, the blowing cylinder being disconnected and the power measured on a friction brake. Under these conditions the mean effective power developed was 575 horse-power, the maximum attained being 670 horse power. The consumption of gas under these circumstances was 111.4 cubic feet per brake horse-power, or 90.36 cubic feet per indicated horse-power. When subsequently operated as a blowing engine the mean power ranged from 561 to 725 horse-power, using gas of a thermal power varying from 876 to 1,000 calories per cubic metre. The gas consumption in these trials averaged 101 cubic feet per horse-power effective, or 82.35 cubic feet per indicated horse-power.

These figures give the remarkable thermal efficiency of 30 per cent., this being the ratio of the power developed to the mechanical work equivalent to the heat of combustion; the heat balance being as follows:

Heat converted into work....	30 per cent.
Heat lost in water jacket......	50 " "
Heat lost in exhaust........	20 " "

Since the thermal efficiency of the best steam engines is only about 12 per cent., and that of most blowing engines is much lower, this is a great advance, and if the ratio of the work done in compressing the air to that produced by the combustion of the gas be taken, we find that the net efficiency of the machine, including the mechanical efficiency of the whole, is about 22 per cent., even taking the higher thermal value for the gas.

These figures are of general interest, but as a matter of fact economy of gas is secondary to effective performance, since the gas is practically a waste product. A fair indication of the satisfactory performance of the engine is found in the fact that plans for three more such engines, of 1,200 horse-power each, are now being made.

Contrary to previously expressed opinions, there has been little or no trouble from dust, the gas being taken directly from the furnace and only cooled before delivery to the engine.

M. Greiner emphasised the great economy attained by the use of blast furnace gases, showing that, apart from the gas required for heating the blast, there is produced, by a furnace making 100 tons a day, sufficient gas for 2,000 horse-power. Taking this as equivalent to 2 tons of coal per hour, or 48 tons per day, and the price of coal at 10s. per ton, the saving would be £24 per day, or £7,200 per working year. Putting the cost of the engines at £6,000, and the building at £2,000, the whole would be nearly paid for at the end of the first year.

Practical Applications of Metallography.

THE study of the molecular constitution of metals, as revealed by etched sections under the microscope, has been considered in many quarters as a laboratory method, of little immediate service in practical work. That this is not the case has been known to a number of conscientious workers in this field on both sides of the Atlantic, and the practical value of the method is well brought out in the papers of Signor R. Schanzer, recently presented before the Institution of Naval Architects, upon the so-called mysterious fractures of steel shafts.

There has been a number of sudden

fractures in shafts and other steel structures which have been subjected to shocks and vibratory stresses, and some of these have been of a most perplexing character, attracting the attention of many of the most authoritative investigators. Most of these fractures represent nothing else than so many cases of brittleness, more or less marked, a phenomenon for which our present knowledge is quite inadequate to account, except in a very limited number of cases.

A very startling feature of such fractures which ought to be noticed is that many sudden breakages in shafts and other structures occur in materials which have been accurately tested before use, and in which the ordinary physical tests uniformly pointed to the best quality of metal. After such a structure has been working continuously for several years in the most satisfactory manner, fracture may suddenly occur, while at the same time no visible evidence of deterioration has appeared up to the very moment of failure, to give warning of the coming danger.

This question of the fatigue of metals has been studied by many eminent authorities, but no definite solution of the matter has yet been reached, and it can by no means be considered as settled. It is, however, possible, by microscopic examination to discover what changes may have occurred in the physical structure of the metal, and it is the result of such examinations which forms the basis of Signor Schanzer's paper.

Signor Schanzer first discusses the views of Professor Arnold as to the effect of the relation of the pearlite, or true steel, present to that of the ferrite, or iron, upon the strength and endurance of the material. A microscopic examination of a piece of steel, under proper conditions, will reveal the manner in which the two constituents are related. When the pearlite and ferrite are closely interlocked with each other the conditions are favorable to the tenacity of the steel, but where the particles are not so interlocked, and there are distinct junction lines between the two constituents, there is liability to rupture under vibratory stresses, because the cohesion or adhesion is inferior to that of interlocked constituents.

Bearing these facts in mind, a study was made of forty-one samples of steel suddenly broken, micrographic examinations being made of samples polished both normal and parallel to the axis of the shafts, and in every case the structure was marked by a distinct separation of ferrite and pearlite, the latter gathering in different points of the section, so that areas of different hardness were formed. In the case of specimens polished parallel to the axis of the shaft, the areas take the shape of elongated stripes. This structure gives rise to hair cracks running in the same direction on the external surface of the shaft.

It is evident that such a constitution is not conducive to strength or toughness. Sharp junction lines between two materials of very different hardness must necessarily cause a tendency of the two surfaces to slip upon each other under vibratory stress. Such surfaces, separating two substances of very different hardness, are certainly surfaces of weakness. In examining specimens of steel to discover this structure it must be remembered that the characteristic stratified structure is only clearly noted on samples polished parallel to the axis. A similar method of examination ought to be also applied to other steel structures, such as plates, rails, etc., in which cases the direction in which the samples are to be polished must be modified according to circumstances.

While it is very important to be able to detect, by microscopic examination, such a structure in steel as is conducive to the formation of cracks, it is still more important that the cause of such structure be discovered, if possible, in order that it may be prevented. In the present state of our knowledge the complete causes cannot, unfortunately, be ascertained, and to enable any thorough study of the subject to be conducted would involve a knowledge of the history of each sample, including chemical composition, manner of working, heat treatment, conditions of stress, etc., etc., and these can only be obtained when the studies are made in direct connection with the work of the manufacturer. There is every reason to believe that the stratification is dependent upon the direction of forging in the case of shafts, and of rolling in that of plates and rails. The percentage of phosphorus present is also a probable factor, and by uniting the tests of metallography with those of the chemical and physical laboratories, these and similar relations should be capable of demonstration.

The serious nature of disasters attending the breakage of shafts, whether at sea or ashore, should make it imperative that every precaution be taken to insure sound metal, and it seems probable that future specifications may include metallographical examinations among the requirements for acceptance.

Heavy Motor Vehicles for Common Roads.

While the chief development of the automobile on the Continent has been in the direction of pleasure and touring vehicles, nearly all the original efforts in England have been towards the more useful if less conspicuous merchandise wagon.

This question formed the subject of an important paper recently presented before the Institution of Mechanical Engineers, by Professor Hele-Shaw, and as he remarked at the beginning, there are strong reasons for thinking that the subject of mechanical propulsion upon common roads has now reached a point where it deserves the very careful consideration of mechanical engineers.

After mentioning the manner in which improvement in this line had been retarded by the law of the "man with the red flag," which made it impossible for any self-propelled vehicle to proceed at a rate of more than four miles an hour upon common roads, Professor Hele-Shaw goes on to show first, how the development of railways has influenced the progress of the nation, and, second, how the proportional increase in terminal charges renders it essential that some improvement be made. "Cartages and terminals exceed the haulage charges over short distances by rail, whilst they become only a very small percentage of the whole when the distances are considerable. It must be obvious that a motor vehicle, which can travel from any one point to another, which absorbs the short cartages into one straightforward journey, and which absolutely eliminates railway terminal charges, has a wide and promising scope for application." By plotting curves showing the relations between conveyance and terminal charges for various distances, it appears that up to 40 miles there is a field for a system of conveyance in the working of which terminals are not included. To this economy must be added the sanitary advantages to be gained by the elimination of the horse, these being well-known, and becoming gradually appreciated.

In discussing the progress which has been made towards the solution of the problem Professor Hele-Shaw divides the subject into three main sections: 1. The behaviour of the wheel upon the road; 2, steering and turning; 3, motive power, including transmission and gearing; these being followed by a summary, together with an appendix of tables.

The behaviour of the wheel is a very important feature, as the injurious effects of a rough road, due to the bodily vertical movements of the whole vehicle, can only be obviated by providing some means of intercepting the shock, either between the wheel and the vehicle, or between the wheel and the road. The former method is found applied when springs are used under the body of the car, but these do not relieve the periphery of the wheels from the shocks which must ultimately destroy them, and hence the best result is obtained by placing an elastic medium between the wheels and the road.

The pneumatic tyre acts in a two-fold manner; it not only interposes an elastic cushion between the irregular road and the vehicle, but it does so by a continuous spring of compressed air extending round the periphery of the wheel. The compression of this air absorbs the obstacle, and thus involves no further work in the compression of the main spring itself. "The advantage of the pneumatic over the iron tyre increases rapidly as the speed increases. Taking 100 as the force required for the pneumatic tyre and iron tyre at a slow speed, the resistance of the iron tyre increased at an ordinary trot to 126, and at a quick trot to 164, and probably if the matter had been investigated for the ordinary speeds of an autocar, the relative resistance of the iron tyre would have been found to rise even more rapidly."

So far as steering and turning are concerned, nearly all vehicles use the principle invented by Ackermann in 1818, both steering wheels being independent, pivoted so that their normals intersect on a point on the line of the axles of the driving wheels. For turning, a differential gearing of the so-called "jack-in-the-box" type is interposed between the driving wheels, to permit them to accommodate themselves to the required conditions.

In regard to motive power, three kinds are at present in use, viz., oil, steam, and electricity, although it by no means follows that some additions may not be made to the list.

Of these the oil engine, or rather, the internal combustion engine, has been found the best for light motors and pleasure vehicles, but it has not yet been applied with complete success to heavy vehicles. The use of electricity depends upon the life and capacity of the battery, and under ordinary working conditions it is found that repairs amounting to about one-fifth the original outlay are required after six months' running. Distances greater than 40 miles, and speeds greater than 10 miles an hour, involve prohibitive dead-weight and excessive discharge rates. Although it would be very desirable to use electricity in view of the advantage of driving the four wheels of a lorry independently, there has as yet been no satisfactory heavy electrical motor brought to the practical stage.

It is therefore necessary to consider that the really available motor is the steam, or external combustion, engine. Many varieties of steam engines have been applied to driving vehicles, but these are merely adaptations of existing types, and the special features are those involved in the construction of oil-burners, boilers, and condensers. Illustrations of many of these are given in Professor Hele-Shaw's paper, and for the details the reader must refer to the original. The burners, which are chiefly for heavy oil, involve some device for vaporising the oil by the heat of the flame, means for regulating the air supply being also supplied in most instances. The boilers, with but one exception, are of the water-tube type, this possessing in a high degree the two essential properties of lightness with strength, and capacity for responding promptly to a sudden demand for steam. The flash boiler, of which the Serpollet is the principal example, involves the use of very thick tubes containing a very small quantity of water, injected continuously and flashed instantaneously into steam.

In all cases the necessity for using a small engine involves its operation at high speed, and hence either gear wheels or chain gearing must be used to bring the speed down to the required extent. Some of these include variable speed gearing, but this is not so essential with steam as with internal-combustion motors.

A number of important tables, showing data from actual operation, are appended to the paper, and from these it appears that the cost of a motor wagon carrying four tons of freight ranges from 3.9 pence per ton mile for 20 miles, to 1.84 pence for 50 miles, the corresponding costs for railway transport being 11.54 pence and 4.37 pence, respectively.

The paper contains very much of value which the limited space prevents from being noticed here, and it should be consulted by all interested in the problem of economical transport.

The Disposal of Town Refuse.

THE question of the disposal of town refuse is one of growing importance, and for this reason the paper of Mr. Brierly Denham Healey, read recently before the Society of Engineers, is of more than passing interest.

In view of the discussion which has been given to the economy attained by the utilisation of heat from the destruction of refuse, the main point is apt to be overlooked. The real question at issue is the complete and inoffensive destruction of refuse. If the heat produced by the combustion can be utilised, so much the better, but the main thing is the complete destruction of the refuse. "The first duty of all sanitary authorities is to collect and dispose of their refuse matter with as little inconvenience as possible to the residents of their own districts, and without causing any nuisance to them or to the residents of bordering districts."

This is the first essential, and if after the complete and inoffensive destruction it is found practicable to recover any of the energy which would otherwise pass off in the form of heat, this should be regarded in the light of a by-product saved, and not as a main result of the process.

A common error is to attempt to pass as much refuse as possible through the smallest number of furnaces, with the consequence, in many cases, of causing a nuisance by imperfect combustion; and, where steam generators have been used, the furnace gases have been forced through them at the greatest velocity, altogether regardless of efficiency or economy.

Although a number of destructor plants have been put in operation in various places in England, it is difficult to compare the results. The refuse in different places differs greatly in heat development, ranging from 200 i.h.p. per ton for Birmingham refuse, to only 12 i.h.p. for refuse from Bath, so that it is not easy to make satisfactory comparisons.

Destructors may be divided into three classes: (1) Those which are intended only to burn the refuse as a sanitary measure, without any attempt to utilise the heat, and from which the clinker is mostly shot into old pits or quarries. (2) Those which have machinery for dealing with a large portion of the clinker, and for which some of the otherwise waste heat is used for generating the steam necessary for driving the same. (3) Those in which every effort is made to utilise fully the effluent gases of the furnaces, and to produce a vitreous clinker, suitable for many useful purposes.

Assuming that a modern plant is intended to destroy the refuse completely, to utilise as much of the heat as is consistent with complete combustion, and to produce a fully vitrified clinker, the following features should be given attention in construction. A high temperature being necessary for the attainment of complete combustion and thorough vitrification of the residue, forced draught is now generally adopted, and hence stacks need not be higher than 60 feet, so far as draught is concerned, but in practice it has frequently been found necessary to carry the height much further, in order to disperse the discharged gases. Some of the older plants had stacks 150 to 180 feet high, one being 300 feet high, but with complete combustion and proper dust catchers such heights are altogether unnecessary.

Too many furnaces should not be connected to one boiler, since the draught is impeded, and the combustion and temperature proportionally lowered. The flue area should be large enough to give a slow velocity to the current and permit the dust particles to be precipitated, but too large a section causes loss by increased radiation, and a mean must therefore be used. Mr. Healey recommends a minimum area of 24 square feet for a plant of not more than twelve furnaces, with 2 square feet extra for each additional furnace. For forced draught there is required about 2 pounds of air per pound of refuse burnt, or say 485 cubic feet per minute for a consumption of 10 hundredweight per hour, but with natural draught double this amount is required.

In the early destructors the boilers were set directly over the fires, and consequently the combustion was imperfect. Modern designs surround the combustion chambers with double brick walls and provide radiating brick surfaces so as to permit temperatures of 2,000° F. to be readily maintained. By preventing the entrance of cold air this high temperature can be kept up and the refuse completely incinerated, the highly heated gases passing from the combustion chamber to the boiler only after the combustion is fully completed.

Mr. Healey discusses the methods of removing and utilising the clinker, showing its applicability to the manufacture of cement, to the production of paving slabs, and to the preparation of bacterial sewage-purification beds.

Water-tube boilers are now very generally used in connection with destructor furnaces, and moveable grate bars have been found desirable to break up the clinker and keep the air spaces open. A number of arrangements of furnaces and boilers are shown in the paper, with data as to their practical performance. In nearly all cases the value of the steam generated goes far to neutralise the cost of destruction of the refuse, this depending naturally upon the character of the material. The average result shows that 1 pound of refuse will evaporate 1 pound of water, and that the net cost of destruction ranges from 2.5 to 11.5 pence per ton.

REVIEW OF THE CONTINENTAL PRESS

Blast-Furnace Gases in Gas Engines.

In these columns there recently appeared a review of the progress which is being made in the development of large gas engines, and it may now be of interest to notice some reports of practical experience in the use of blast-furnace gases in these engines, which have appeared in *Stahl und Eisen.*

Herr F. Werndl, of the Friedenshütte, in Silesia, says that when one considers the scepticism and doubt expressed about the use of blast furnace gases in gas engines only a short time ago, it is astonishing what rapid progress has been made in this field. The chief difficulties anticipated were the amount of dust in the gases, their small percentage of combustibles, their varying composition and the aqueous vapour they contained. The dust, which caused the most apprehension, is found in practice to be much less of an obstacle than was anticipated. The gases pass through various cleaners which remove nearly all the dust, and the small amount which gets into the cylinder is practically all blown out again.

There was concern felt about the low percentage of combustible, as it was thought this would necessitate an increase in the size of the engines, and might cause difficulties in the ignition of the charge. But actual experience has dissipated these doubts. The varying composition of the gases is almost always equalised when more than one furnace is in blast. But even if there be only one furnace, the governor of the engine takes care of irregularities in the gas by admitting a greater or less amount to the combustion chamber. Finally, the water vapour may indeed lower the calorific intensity of the gases, but practice shows that the calorific intensity is ample, when the gases are adequately compressed, to produce all necessary power at the moment of explosion.

At the Friedenshütte plant, the blast-furnace gases have to travel a distance of about 500 meters before reaching the engines, which gives them a good opportunity to get rid of their dust. After leaving the furnace, the gases pass through several stand-pipes and five dry cleaners, then through a long pipe to some more stand-pipes, and then to the "coke-scrubbers," which latter, however, are now left empty, as the porous coke became clogged up with the fine dust and stopped the flow of gas. From the scrubber, the gas flows through a sawdust purifier into a gasometer, from which it is led to the engine.

While the amount of dust suspended in the gases after passing the dry cleaners at the furnace is 5 grams per cubic meter (2.2 grains per cubic foot), it has fallen to 0.6 or at most 1.6 grams per cubic meter (0.26 to 0.7 grains per cubic foot) by the time the sawdust purifier is reached, and after leaving the latter there is only a few thousandths of a gram of dust in each cubic meter.

Before passing the sawdust purifier, the moisture amounts to about 13.5 grams per cubic meter (5.9 grains per cubic foot), and after passing through, to about 5.5 grams (2.4 grains per cubic foot). An analysis of the gases before entering the engine gave 28 to 30 per cent., by volume of CO, 6 to 7 per cent. of CO_2, and 3 to 3.5 per cent. of H. The amount of gas consumed by the engines varies. The greater the load, the less, in proportion, is the gas consumption. The 200-horse-power engines, when carrying a load of only 90 horse power, use 6.6 cubic meters (231 cubic feet) per horse-power hour, but when loaded up to 177 horse power, the consumption of gas sank to 3.8 cubic meters (133 cubic feet) per horse-power hour. It can thus be seen that at full load these engines would require only 3.5 cubic meters (123 cubic feet) per horse-power hour. In this plant are two 200 horse-power gas engines, each connected by means of a leather coupling to a dynamo which furnishes continuous current for lighting, and two 300 horse-power gas engines, each rigidly coupled to a rotary current generator.

At the Donnersmarckhütte, also in Silesia, there is, according to Herr Müller, a 100 horse-power Körting gas engine, fed by blast-furnace gases. This engine has one cylinder, operates with four strokes to a cycle, and has valve gear, and a governor which regulates the amount of gas used. The diameter of the cylinder is 50 centimeters, the length of stroke 85 centimeters, and the number of revolutions 130 per minute. Directly coupled to the engine is a shunt-wound, continuous-current dynamo, also built by Körting.

The blast-furnace gas used has a calorific intensity of about 1,000. An analysis gave 31 per cent., by volume, of CO, 7.8 per cent. of CO_2, and 3.4 per cent. of H. The gases are cleansed of dust by passing through a "scrubber" and a sawdust purifier. As at the Friedenshütte, it was found that coke in the scrubber soon became clogged and hindered the flow of gas, so that now water is sprayed through the gases in the scrubber, collecting the dust particles and carrying them off through a siphon. This works very well. The amount of dust is not great, being about 1.5 kilograms per day for the 100-horse-power engine. The final cleansing is done by two layers of sawdust, 10 to 15 centimeters in thickness, which are renewed every four weeks.

At full load the engine uses 2.6 cubic meters (91 cubic feet) of gas per horse-power hour; at three-quarters load, 2.7 cubic meters (95 cubic feet); at half load, 3.1 cubic meters (109 cubic feet), and at one-third load, 3.5 cubic meters (123 cubic feet). It follows from these figures that the machine should be designed so as to run at nearly full load in order to produce the best results.

In comparison with steam engines, it may be said that the gas which used in a gas engine would produce 3,700 horse power, would, if employed as fuel for boilers, generate only 1,000 horse-power with the steam engines in common use in metallurgical works. Even if the best modern triple-expansion steam engines were used, they would develop only half as much power as the gas engines, with equal amounts of gas, and at the same time the first cost would be much higher. These large gas engines are found most serviceable in running electric generators, which supply current for every required purpose, forming a most flexible and efficient system, and one peculiarly adapted for mining and metallurgical work.

Some German Machinery at the Paris Fair.

GERMANY is making a splendid showing at the Paris Exposition. Her work there has been done with that systematic thoroughness which is aiding her so much in the great commercial struggle going on all over the world. Germany is very much in evidence in many parts of the Fair, but nowhere does she show to better advantage than in the foreign section of Machinery Hall. One of the interesting exhibits there is the great Carl Flohr travelling crane, which has helped not a little to put the German section in the advanced state which has been remarked by so many observers. This crane spans the entire width of the hall, its upper arch conforming approximately to the curves of the roof trusses, and runs on tracks laid at the floor level close to the walls. Besides the upper arch, which at its highest point is 22.12 meters above the floor, there is a horizontal stiffening girder with a clear height of 12.5 meters. This horizontal girder carries the crane carriage, as well as platforms, and is connected with the center of the arch by a vertical latticed post, which helps to support the horizontal girder and stiffens the whole structure.

The crane is supported by columns which, toward the bottom, spread out fore and aft to a distance of 8 meters, in order to afford a long enough base and prevent any possible danger of upsetting. Each column rests on four trucks, which have two wheels apiece, all eight in line ahead. The wheels are flanged at the middle and run on two T rails, laid with their centers 11.8 centimeters apart. The crane has a span of 27.6 meters, and as it travels the entire length of the hall, 107 meters, it commands every part of the floor, and is high enough to clear everything. The 26 horse-power electric motor which drives the structure up and down the hall, is placed in the gallery on the horizontal girder, and its motion is transmitted to the wheel axles by means of horizontal and vertical shafts and bevel and worm gearing. The speed along the tracks can be raised to 30 meters a minute. The travelling carriage is driven by an 8 horse-power motor placed upon it, and it also carries two motors, of 18 horse-power apiece, which work the lifting chain. The carriage can run at a speed of 18 meters a minute, and a load of 30 tons can be lifted at the rate of 2.4 meters a minute. The motors get their current from a conductor, supported on brackets on the side of the hall, by a sliding contact.

Among the machines which have been erected by this crane are four sets of generating apparatus which constitute the German part of the great power and lighting plant in Machinery Hall. Each set consists of a steam engine directly coupled to a dynamo.

These few points, taken from the *Zeitschrift des Vereines Deutscher Ingenieure, Glaser's Annalen,* and the *Elektrotechnische Zeitschrift,* touch on only one portion of the German machinery exhibit. Some of the installations referred to are illustrated in Mr. Donner's article appearing elsewhere in this issue (pp. 529-542). As a whole, it shows the enormous advance made by Germany in the development of technical industry, and may well give her commercial rivals cause for serious consideration.

Electric Locomotion on European Railways.

WHILE electric locomotion is assuming increasing importance in American railway work, it may be of interest to cast a glance at some European developments in that line, as set forth by Herr Frahm, in *Stahl und Eisen.*

The Paris-Lyons-Mediterranean Railway has for some time been making experiments on its main line, near Paris, with an electric locomotive which gets its current from a storage battery placed on a tender. This locomotive has a forward running axle and two rear driving axles 2.2 meters apart, on each of which is a continuous-current motor. The locomotive itself carries only a small auxiliary battery, which serves to excite the field magnets, to work the air compressor, and to furnish light. It is doubtful, however, whether accumulators will be used permanently. They have been employed principally as a convenient source of current for experimental purposes, as motors could be tested in this way without making any changes in the railway itself.

In Germany, on the 52-kilometer connecting link of the Pfalz Railway system, between Worms, Ludwigshafen, and Neustadt, accumulator cars with two 50 horse-power motors have been in operation since 1897. Two ordinary third-class carriages have been fitted up as motor cars and carry under their seats a battery large enough to drive the car, together with one or two trailers, at an average speed of 45 kilometers an hour. The total weight of a motor car is 24.4 tons, which includes 9.3 tons of battery and 4.1 tons for the two motors. The battery for one car consists of 124 hard-rubber cells, and when discharging at the rate of 150 ampères has an average electro-motive force of 225 volts and a capacity of 200 ampère hours. The average energy consumed by one motor car, with a seating capacity of 38, hauling one trailer weighing 10 tons, empty, and having seats for 50 persons, is 832.5 watt hours per train-mile. On the 23-kilometer standard-gauge line between Stuttgart and Plochingen an accumulator motor car has been in operation since 1897. This is also a converted third-class carriage, which is fitted with two 35 horse-power motors and carries a 5.8-ton battery in a box under the car body, between the trucks. It runs at a speed of 30 kilometers an hour on a line which has heavy grades and several curves.

In Italy the prospects seem promising for a wholesale electrical equipment of the railway system, on account of poor and expensive coal and cheap and abundant water-power. The first standard railway to be run electrically was the 13-kilometer section of the Mediterranean road, between Milan and Mouza, where an accumulator system was put in operation in February, 1899. This system was used in order to avoid making any changes in the road itself. The cars are 17.8 meters long, have 64 seats for first and second-class passengers, and rest on two four-wheel trucks. Each truck carries a powerful motor, and the cars attain a speed of 45 kilometers an hour. There are 130 cells of battery, which are charged in one hour, and which then run the car for 80 kilometers. The Adriatic Railway is also about to equip its 42-kilometer section between Bologna and San Felice with large accumulator cars which can carry 60 passengers.

Among standard railways which are operated by the trolley system may be mentioned the road between Düsseldorf and Crefeld, 22.5 kilometers in length, which carries both passengers and freight, and besides handling the traffic between its terminal points does a large local business between intermediate stations. Other German roads, as well as Austrian, Hungarian, French, and Italian, are being equipped with trolley and third-rail systems, the latter seeming to have the preference where the traffic is heavy.

Switzerland, however, is the most active European country in the electric-railway field, as the natural conditions are so particularly favourable. Its many mountain streams and waterfalls furnish an economical and plentiful source of power, which is being rapidly developed. There is a great deal of attention being devoted to branch lines and lines into side valleys, where the heavy grades make rack railroads necessary. In some cases high passes and even mountain tops are reached by electric railways, as, for instance, the completed Görnergrat road, near the Matterhorn, and the Jungfrau road, now only partly finished. The principal standard-gauge electric road in Switzerland is the one between Burgdorf and Thun, 41 kilometers in length, opened last summer.

Rainfall and Sewers.

In a recent issue of the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines,* Herr Eduard Bodenseher describes a practical and thorough method of determining the amount of rainwater which it is necessary to provide for in the construction of sewers and drains.

Every plant has, naturally, to be treated individually, but when adequate data, particularly complete plans and profiles of the district in question, are given, the system of sewers and drains can be designed in a thoroughly scientific manner.

Among the preliminary points which have to be determined, the local rainfall is most important. But it must be remembered that the heaviest strain on the capacity of a sewer system is not caused by the quiet, steady, long-continued rains, but by sudden, violent downpours which are of comparatively infrequent occurrence and which last only a short time when they do happen. It becomes, then, of interest to see what the chances are of these heavy rainstorms. Of course, this depends very much upon the geographical position of a place, it having been observed that violent rains are heavier and more frequent in mountainous regions than in a flat, low country, and, also, that the more violent such a storm is, the shorter, the less frequent, and the less extensive it becomes. It would be uneconomical to build sewers large enough to hold the greatest possible amount of rainwater that could ever fall, and various practical considerations will determine the rainfall which is taken as the basis of calculations. From many observations made in European cities, extending over periods of years, Herr Bodenseher concludes that a fair general rainfall figure for these heavy showers is 90 liters per second on a hectare (0.00036 inch per second), lasting from 15 to 20 minutes; or, in extreme cases, in large, closely built-up cities, 100 liters per second per hectare (0.0004 inch per second), lasting 30 minutes.

But the total rainfall is one thing, and the amount which flows off from the surface generally quite another. It is only the latter which has to be taken into account, and here again observation and experience have provided figures for the use of the engineer. The rain which falls may be divided into three parts: that which evaporates, that which is absorbed by vegetation and the earth, and that which flows off on the surface. The first may be disregarded, for the heavy rains with which we are concerned almost always occur when the air is so saturated with moisture that the evaporation is negligible.

The proportion of water absorbed varies very greatly, from more than 90 per cent. in wooded regions, to nothing on roofs of buildings, but in designing a sewer system, particular attention must be given to the conditions which obtain in cities.

Herr Bodenseher uses some coefficients which are given by Kuichling as the result of observations in American cities, the number in each case meaning the proportion of water which flows off on the surface.

1.0 for roofs;

0.8 for sidewalks, asphalt, wood pavement and stone pavement with water-tight joints;

0.5 to 0.6 for well-trodden paths, rough stone pavements, and macadam;

0.4 for unfrequented foot-paths and gravel roads; and

0.2 for dirt roads, gardens, lawns, and railroad tracks.

These figures enable us to determine the greatest amount of water to be provided for, by taking the rainfall on any area and multiplying it by the appropriate coefficient, which will give the total discharge of water from the surface of that area.

But there is one other point to be taken into account before fixing the size of the sewers: The rainwater does not flow off instantaneously, but takes time to reach different points of a sewer net-work, and if this time, for any point, is greater than the duration of the rainfall, the flow from the area near the point will have ceased before the water from the most distant parts arrives, and so the rate of discharge past this point will not be as great as the total rate of discharge from the drainage area. This retardation in discharge is particularly emphasised by Herr Bodenseher, who takes it into account in his calculations, and who lays out discharge curves for many points of a sewer system, so as to determine the sewer sections with scientific accuracy. He has applied his method practically in the design of a sewer system for Troppau, in Austrian Silesia, with such success that he received the first prize in a competition instituted by authorities of that city.

Railway Improvements About Paris.

At this time, when the tide of travel sets so strongly toward Paris, it may be of interest to review a paper by Herr Frahm, in a recent issue of *Glaser's Annalen,* where he describes some of the improvements which have recently been made in the terminal facilities of the railways entering the French capital.

The terminal stations in Paris, up to a short time ago, were the following:

1. The Eastern Station, the terminus of the Eastern Railway.
2. The Lyons Station, the terminus of the main line of the Paris-Lyons-Mediterranean Railway, which has also another station, the Vincennes, the terminus of its branch line to Vincennes.
3. The Orléans Station, on the Place Walhubert, the terminus of the Orléans Railway, which has a second station at the Luxembourg Garden for the branch line to Sceaux.
4. The Montparnasse Station, where the Brittany lines of the Western Railway terminate, and which also accommodates the Government Railway.
5. The Moulineaux or Champ de Mars Station, which also belongs to the Western Railway, and serves principally to accommodate the suburban traffic with St. Cloud and Sèvres.
6. The St. Lazare Station, the terminus of the Western Railway lines which come from the lower Seine and Normandy.
7. The Northern Station, the terminus of the Northern Railway.

All these stations are connected by the Paris Belt Line, which encircles the whole city in the vicinity of the fortifications, and was finished in 1867; but it is only within the last ten years that the railways began to penetrate the real center of the town, which is that part lying on both banks of the Seine between the Hôtel de Ville on the east and Champ de Mars on the west.

In 1892 and '93 the Sceaux branch line was extended about 2 kilometers in tunnel and open cut to its present terminus at the Luxembourg Garden.

The Orléans Railway soon had an opportunity to take advantage of the experience it had gained in this work. For many years its station on the Place Walhubert, on the left bank of the Seine, in the southeastern part of the city, has been getting farther and farther away from the heart of the town, which is moving steadily westward, and so the Orléans Company has been anxious to extend its main line toward the west. Its chance came when it was enabled to acquire a large piece of government property on the Quai d'Orsay, on the left bank of the Seine, opposite the Tuileries, and about 4 kilometers below the Place Walhubert. Since then it has been running a two-track extension along the left bank of the Seine to the Quai d'Orsay, where it has built a new terminal station. This extension lies partly in tunnel and partly in a subway right under the pavement. This subway lies so close to the Seine, that it can have numerous side openings, above high-water mark, giving directly on the Quais, which afford ample ventilation. But as the tracks at the Quai d'Orsay Station are all underground, it was found expedient to use electric locomotives of the so-called Hoboken type. with four driving axles, on the extension These locomotives have a power of 500 kilowatts, and can haul a 200-ton train at the rate of 35 kilometers an hour.

As already mentioned, the lines of the Western Railway terminate at the three stations of St. Lazare, Montparnasse and the Champ de Mars. The latter is conveniently situated, but has heretofore been of little importance, as it was used only by the Moulineaux line, a suburban road to St. Cloud. The two others, though, are at a considerable distance from the center of activity on the Seine. It has been particularly difficult to get trains from the St. Lazare Station, which lies in the northwestern part of Paris, to the Champ de Mars. A wide detour of 25 kilometers had to be made around the western end of the city, whereas the air-line distance between the two stations is only 4 kilometers. A convenient connection has now been made by converting the Belt Line between St. Lazare and the Trocadero Station into a four-track road, and having two tracks branch off from the latter point and proceed by tunnel and open cut under the Passy section of the city, then across the Seine by a steel bridge, and up the left bank to the Champ de Mars. From there the new line is continued parallel with the river, in open cut and subway, to the Esplanade des Invalides, where there is an extensive underground terminus. Provision is made for a future connection between this station and that on the Quai d'Orsay, only a short distance away.

These changes, however, did not improve the situation at the Montparnasse Station, in the southern part of the city, where there is not only considerable through traffic but also a heavy local business with Versailles, all carried into the city on two tracks. It was found impracticable to make a four-track road here, and even had this been done, passengers would not have landed any nearer the center of the city. So it was decided to build an entirely new line, which branches off from the main road at Viroflay, near Versailles, proceeds through a 4-kilometer tunnel under the Bois de Meudon, and joins the Moulineaux Railway on the left bank of the Seine, near Issy. From here it continues up the river to the Champ de Mars, where it joins the new Trocadero line and runs into the Invalides Station. This new road promises to have its capacity severely taxed, and as it will run for so great a distance through tunnel and subway and will terminate in an underground station, it is to be equipped with a combined electric and compressed-air system. In general, it will be run on the third-rail system, with powerful electric locomotives, but there will also be compressed-air locomotives for switching service at the Invalides Station, for helping out on the particularly heavily travelled section between the Champ de Mars and the Invalides, and for assisting any trains which may possibly get stalled in the Meudon tunnel.

Improvements are also under way at the Eastern and the Lyons Stations. The latter is being completely rebuilt and modernised, and the number of tracks on the Lyons road has been increased to four for a distance of 16 kilometers outside the city, with a purposed future increase of the number to six.

All these changes and improvements have doubtless been hastened by the coming of the Exposition, and though they may not all be finished in time for the rush of travel this summer they will contribute to the lasting benefit of the travelling public at Paris.

REVIEW OF THE AMERICAN PRESS

Electric Driving for Factory Machinery.

It has been said that the unhesitating "scrapping" of superseded machinery, however costly it may have been, is the foundation of success in manufacturing. The principle is largely admitted and consistently acted upon in American shops, but Prof. Wm. S. Aldrich, in an excellent paper presented at the latest meeting of the American Society of Mechanical Engineers and forming part of Volume XXI. of the *Transactions,* calls attention to the fact that though "each year more and more machinery is thrown into the scrap heap to make room for new and improved types, yet antiquated and costly methods of transmitting power are left in service. Modern methods of workship production, in which machine tools are worked up to the power limit, are seen to be sought after side by side with belted transmission of power, which makes it quite impossible to realize fully the value of the new method."

In most new installations, as Professor Aldrich says, electric transmission has received full consideration, but in older plants it has to fight its way against the established usage of shafting, belting, and rope drives. It is not, as he hastens to show, a universal panacea; "there are many factories and mills in which the introduction of electricity for power transmission will not pay"; but there are more in which the investment necessary for the change would be dividend paying. Each case must be considered individually. For certain very definite reciprocating motions hydraulic mechanisms are best suited: "for reciprocating movements requiring a cushioning effect, compressed air is best adapted"; but "for all manufacturing operations requiring rotary motion, continuous or intermittent, uniform or variable, and reversible or otherwise, electric motors provide the readiest facilities."

The main general advantages of the electric-transmission system are thus summed up: Centralization of the mechanical plant, for light, heat, and power; ability to place the plant near to coal and water-supplies; possibility of locating the engine at any convenient distance from the machines, unfettered by length or direction limitations of shafting; and subdivision of the generating plant into duplicate and interchangeable units, each of which can be loaded to the normal capacity, so that the portion of the power plant running may always be kept under practically uniform load. "The introduction of electric transmission has been greatly facilitated by the recent standardization of electrical machinery, and especially that required for power purposes. This, furthermore, facilitates repairs and renewals, if it were necessary to advance this as an argument in favor of electricity. Fortunately, electric machinery as made to-day requires the simplest moving parts and the fewest repairs and renewals."

Passing to the discussion of efficiency, Professor Aldrich points out that the friction loss of all mechanical-transmission systems being practically constant, the efficiency of such a system falls off rapidly below full load. He gives curves of variation of efficiency of a 275 horse-power engine, having a mechanical efficiency of 90 per cent. at full load, operating heavy machinery. The friction losses are plotted from actual values as given by Prof. C. H. Benjamin, in a paper recently presented to the Society. The resultant is that while with "100 per cent. load there is 45 per cent. available for useful work, at three-quarters load there is only 28 per cent. available for work and at 55 per cent. of the full load there is nothing left for work, all power being consumed in overcoming the combined friction of the engine and the transmission machinery."

Against this, electric motors are characterized by high maintained efficiencies at part load. Curves are given showing the combined or "plant-efficiency" of engine and dynamo supplying power for electric motors of different sizes. Taking the extreme case of twenty 10 horse-power motors (requiring a steam-generating plant of 275 indicated horse power), at full load 63 per cent. of the engine power is available for work; at three-quarters load, 62 per cent.; at half load, 51 per cent.; and not until we drop to something less than one-quarter load is the entire power consumed in engine, dynamo, and motor losses. The performance of the mechanical plant declines very rapidly below full load; the best performance of the electrical system may be maintained all the way from three-quarter load to 25 per cent. overload.

In the matter of distribution, a composite system may be best, even for so short distances. Direct or alternating current, and simple, two-, three-, or four-wire systems are all adapted to different requirements. Preferably all distribution should be direct, avoiding storage batteries, rotary converters, and transformers, except for special lines of work. A wide range of voltages is possible, but Professor Aldrich deprecates the use of a higher voltage than 550.

With direct-current motors, resistances made the control of torque and speed simple, but at the useless expenditure of energy. The Ward-Leonard system, with its two additional machines, came to the rescue and has been successfully and extensively used in elevators, cranes, etc. "The difficulties with commutators have been almost entirely overcome," and "such objectionable features as remain * * * are inherent in the direct-current system used, and are found to lie chiefly in the kind of armature, commutator, and brush devices required. Rough usage, dirt, and the difficulty of expert care and daily inspection have hindered the electric motor from making a better record in its early history. The alternating-current system with its induction-motor service is "probably the most perfect yet developed" in factories and mills. The motor "may be started and operated from any point, at any time, at practically any load and speed within its predetermined ranges. It may be used on 110-, 220-, 440-, or 550-volt alternating-current circuits of one, two, or three phases. It does not require any direct-current supply as the synchronous motor does for its field excitation. It does not require any brushes, commutators, or collecting rings." Offsetting this are the large generating-power-plant required, the slight falling off of speed as the load is increased, and the sacrifice of some efficiency on starting under heavy load and also upon speed changes during operation. By suitable arrangement of field windings, the speed may readily be altered in regular steps. In ordinary shop usage, the "slip" is not objectionable, and the great advantage is the ability of the motors to stand heavy overloads and the impossibility of burning them out.

"Synchronous motors are admirably adapted to factory service where absolute uniformity of speed is required, and where the extra installation of a direct-current supply for their field excitation is not deemed objectionable." They may be overloaded to at least three times the normal load without falling out of step. Where the motors are designed, installed, and operated under the best conditions the power plant need not be larger than that for direct-current working.

The "ideal conditions in a factory installation," Professor Aldrich finds in the use of both induction and synchronous motors —"the former for small machines and direct driving, the latter for operating a set or group of machines. The synchronous motors would be started up just before beginning the work of the day, have at all times a light constant load, and might easily be so regulated as to produce an almost balanced system in combination with the induction motors. * * * The whole system would be operated practically throughout quite a range of load variations, as if it were a simple direct-current system. The advantage of such a system is apparent; it means least installation for any given output, or greatest output for any given capacity of generating plant. The group method of driving is much better adapted for small machines up to and including 2 horse-power capacity, and especially where such machines are in almost constant service. Above this size, individual motor driving becomes more and more efficient, particularly if the machines are operated only a fraction of the day."

Cape Nome.

CAPE NOME, the newest gold producing wonder of the Pacific United States, is attracting livelier attention as the opening of its second season draws near. The production of the first summer—1899—is said to have exceeded $2,400,000 and a much larger output is expected in 1900. Relatively to its age, the district is comparatively well studied, and a very good idea of the occurrence and origin of the gold is given by Messrs. F. C. Schrader and Alfred H. Brooks, in the *Transactions of the American Institute of Mining Engineers,* while an article by Mr. Charles G. Yale, statistician of the United States Mint, San Francisco, in the *Scientific American Supplement,* gives a shorter account of the Nome deposits, contrasting them with the gold sands of the California beaches and presenting some details of the methods of working, which so far have been decidedly crude.

There has been manifest lately a strong disposition to believe that the entire sea floor of Bering Straits and the ocean south of them is auriferous, and current newspaper stories give a circumstantial account of a "syndicate" which has secured "concessions" for the entire northeastern Siberian coast, from which untold wealth is to be extracted. All three of the writers just mentioned, however, refer the source of the gold to the mineralized veins and country rock back from the coast on the American side. Messrs. Schrader and Brooks say they "wish to emphasize this, because of the popular idea that the Nome placer gold has been brought from great distances by the action of the ice, or through some convenient convulsion of nature." Mr. Yale feels no doubt of the agency of glacial action, but it is that of the glaciers coming down from the hills behind, whose "terminus * * * was the ocean, where they became disintegrated and gave up their burdens of stone, gravel, gold, etc." This idea is supported by the fact that the gold "is more or less angular and does not seem to have been much water-worn, as in ordinary placers"; "many pieces are found with the quartz still clinging to them"—a fact mentioned also by Messrs. Schrader and Brooks; "on the Nome tundra, the presence of gold is not confined to the beds of waterways, but it is found all over the district, being, however, concentrated in larger quantity in the creek beds, where moving water has gathered it."

Another writer in the *Scientific American* states that at the breaking up of winter "the ice cakes of the streams invariably bring down loads of gravel which is deposited as they are dissolved by the heats of summer. This theory is responsible for the general belief that the deposits of gold-bearing gravel cover the entire floor of Norton Sound." It is generally agreed that the deposits extend seaward, and many projects for dredging beyond the surf are to be tried, it is said, this summer. The difficulties of deep dredging on an exposed coast are manifest, and the efforts so far made in this direction have not been encouraging.

Messrs. Schrader and Brooks describe the Nome region proper as an ill-defined area in about the center of the southern margin of the Seward peninsula, about 100 miles southeast of Bering Straits. Here a crescent-shaped, moss-covered plain stretches inland from the coast, having an extreme width of 4 or 5 miles. Cape Nome forms its eastern and West Point its western apex. To the north this plain is broken into a succession of ridges, the highest one of which merges with the rounded slopes of the mountains. The drainage of the region is taken to the Bering Sea by several streams of considerable size, which have broad valleys with gently rising slopes. * * * A striking feature of the topography is a series of benches and terraces which occur in the plain and on the mountain slopes."

"From the standpoint of the gold-seeker the most interesting formations of the regions are the gravels. These are found forming stream terraces along the creeks and marine terraces in the tundra, and on the mountain slopes. Their presence indicates a gradual elevation of the entire area. The pebbles of the gravel, as far as we have observed, can usually be traced to some local source."

These authors group the placer deposits as gulch placers, bar placers, beach placers, tundra placers, and bench placers. Only the gulch and beach deposits have produced largely as yet. The gulch placers, consisting of the "flood plain or gravel deposits of the streams," vary from twenty to several hundred feet in width; the gold is not evenly distributed through them, nor is the pay-streak (which is usually on or near to bed-rock, under 5 to 8 feet of gravel) continuous; detached pockets are sometimes very rich. The gold is "usually rounded, and often smoothly polished"; the nuggets are round and sub-angular, seldom flat, and vary from the size of a pin-head to 25 ounces, many of them being "about the size of a No. 3 shot, while nuggets from ½ ounce to 1 ounce are not uncommon."

The beach placers, in which the gold is much finer, ranging in size from a pin head to flour gold, are largely "a concentration of the gold carried by the gravels and sands of the tundra," under the cutting influence of the waves. The gravels and sands are carried away by the undertow, while the heavier gold sinks downward in the sand near the water line. Messrs. Schrader and Brooks suggest that, as similar action has undoubtedly taken place at other stages of a constant elevation, rich ancient beaches may be found in the tundra, which must not, however, be expected generally to show any such richness as is found in the beach.

Bench placers have not yet been worked to any extent, chiefly on account of the difficulty of getting water. Nor have the bar placers been largely developed, although it was on the bars of Snake River that gold was first discovered at Nome.

The open season extends from June to November, and communication is kept up during the winter by dog and reindeer sleds. There is no harbor, and landing must be made by barges. The absence of timber is a serious drawback, and will be felt more severely when the present supply of driftwood is exhausted. Lumber and coal have been extremely dear, through the failure of dealers to appreciate the markets afforded; but the comparative accessibility of the region will no doubt lead to an enormous influx during the summer of 1900.

The Coal Fields of Shansi, China.

It does not require a very severe nor a very long-lasting coal famine to advance the question of the exhaustion of fuel supply from a purely academic discussion to one of pressing economic importance. The present situation in Great Britain brings the matter near enough home to lend a heightened interest to the description of the coal-fields around Tsê Chou, Shansi, China, by Mr. Noah Fields Drake, which was presented at the last meeting of the American Institute of Mining Engineers and is printed in their *Transactions.*

The district was first adequately examined by Baron von Richtofen, in 1870, but the anti-foreign attitude of the Chinese government has since prevented development, until now its exploitation by the Peking syndicate seems to be at hand, this English-Italian company having concessions to work the coal of the Tsê Chou region as well as of the Shansi fields.

The Tsê Chou coal area examined by Mr. Drake lies about 300 miles southwest of Tientsin and about 500 miles northwest by west from Shanghai, and shows a "mingling of ridges, hills, narrow elevated valleys and rough rolling lands." The rock beds lie comparatively level, with some conspicuous folding and faulting giving narrow belts of eastward-dipping strata and long west-northwest dipping areas in which the dips are rarely greater than 7° or 8°, and "the average dip of the whole earth-crust block is probably not more than 1° or 2°; 22 to 23 feet is given as the probable average thickness of the main workable Tsê Chou coal bed, though Mr. Drake had no opportunity to measure its full thickness nor to examine it except where it is being mined. At one mine, near Hsi Ta-yang, only the lower 10 or 12 feet is being taken out through a shaft 329 feet deep. Mr. Drake was told by Chinese miners that the full thickness of the bed is 30 feet Chinese, equal to 36 feet English. Parting streaks of shaly coal are common, but no waste coal is taken out, and the average ash is probably not higher than 10 per cent. In two mines a couple of miles northeast of Tsê Chou Mr. Drake saw coal-beds from 17 to 23 feet thick, the latter being made up quite uniformly of a lower stratum of 3 feet of earthy friable coal, 14 feet of hard, firm, evenly good coal, 1 inch of carbonaceous shale, and 6 feet more of good coal. In a mine 1½ miles west of Ta-chi, where the Chinese miners said the bed has a thickness of 23½ feet, Mr. Drake saw the upper 15 feet only.

The coal "is wonderfully bright and glossy throughout. It breaks with a conchoidal fracture, and is so free from dust that it can often be handled without soiling the hands."

The area mapped by Mr. Drake, about 150 square miles, contains about 3,000,000,000 metric tons, supposing 22 feet to be the average thickness of the bed and 1.5 the average specific gravity. And "it must be remembered that this area is only a little of the ragged edge of the great coal-fields of Shansi. * * * Richtofen estimates that the anthracite coal alone of Shansi amounts to 630,000,000,000 tons, and that the coal area of Shansi is greater than that of Pennsylvania."

The Tsê Chou coal is all anthracite, hard enough to support any weight in the blast furnace, uniformly low in sulphur and comparatively low in ash.

The limitations to Chinese engineering ability, which Mr. Parsons epigrammatically defines on another page of this magazine, are strikingly apparent in the methods of Tsê Chou. The coal is dug, hoisted, and transported without explosives or power applications. Mining is done with pick and gad; the coal is raised by a man-power windlass, which in the larger mines may have a circumference of five feet; a crank at each end, with a long arm, allows four or five men to work at turning it. About 300 pounds of coal are hoisted at a time, in baskets. From the foot of the shaft, tunnels are run through the coal-bed, and at intervals large quantities of coal are taken out, leaving rooms about 40 to 50 feet in diameter. Very little coal is taken out through inclines, and none through tunnels, though in some cases a horizontal tunnel as long as the vertical shaft would cut the coal.

The output is about 50,000 tons per annum from the Tsê Chou area, and it is carried to its market, locally or on the plains 20 miles away, in little carts drawn by oxen or, far more largely, by pack animals—mules, donkeys, and men. The trails are "from 12 to 14 feet wide and paved with stone. By ages of use, these stones have been worn until their tops are smooth and spherical in shape. Over these rough and steep trails there is, during fair weather, an almost continuous line of pack animals passing to and fro, and most of these are employed in carrying coal."

Mr. Drake points out the striking contrast between present conditions and the possibilities under modern methods. Richtofen has suggested that the horizontal beds would allow long railroad tunnels to be run directly into the beds, within which cars could be loaded for distant transport. The completion of some of the projected railways will doubtless bring an enormous development of the region.

Proposed Standard Specifications for Steel.

THE progress of the International Association for Testing Materials has been frequently noted in these pages, and it is most gratifying to friends of the movement, as it must be especially to the American Branch of Committee No. 1, to find how appreciative a reception is given to the fruits of their work, just distributed. These take the form of ten bulletins, each devoted to the specifications for one class of material as adopted for recommendation by the American Section of the Association, the list being as follows: No. 8, Structural Steel for Bridges and Ships; No. 9, Structural Steel for Buildings; No. 10, Open Hearth Boiler Plate and Rivet Steel; No. 11, Steel Rails; No. 12, Steel Splice Bars; No. 13, Steel Axles; No. 14, Steel Tires; No. 15, Steel Forgings; No. 16, Steel Castings; No. 17, Wrought Iron. Extended notice of the bulletins and the Committee report accompanying them is given by the *Engineering Record, Iron Age,* and *Railroad Gazette.*

The *Gazette* presents what it calls "three tables, giving synopses of the proposed specifications," which, however, are in reality tabular statements of the many individual specifications of leading engineers, manufacturers, and railroad companies forming the basis of the proposed standard specifications put forth by the Committee. The *Iron Age* gives a comparative and discriminating review of the nine specifications for steel, tracing the various requirements specified throughout the entire list. The *Record* gives the substance of three of the bulletins, with an excellent editorial commending the labors and wisdom of the International Association and expressing the general conclusion that "the proposed specifications * * * represent, at least fairly well, features of good practice." It calls attention, however, to the fact that: "In the specifications for bridges, buildings, and ships, there is found no reference to high steel, *i. e.,* steel running in ultimate resistance from 70,000 to 78,000 pounds per square inch. It is true that much of such material is not used, but some is, and more is likely to be * * * in bridges and buildings it is well adapted to column designs, and it is likely to become more so. There seems to be no reason why such steel should not be recognized, and it would be a matter of no surprise if discussion should justify that observation. Similarly it would seem only reasonable to give structural steel for buildings the same range in classes of material as that for bridges."

A broader point, perhaps, is made in the concluding criticism that "The ductility of the material is in all cases measured by the elongation only. * * * It should be carefully considered whether that is not a mistake. The reduction of area is in many cases a most valuable indication of ductility, and in all ordinary testing it is a feature which practice enables to be measured with ease. Its omission is a serious matter and may not be justified." It is our impression, however, that the association acted advisedly in omitting the reduction-of-area specification, and will be able to support its position ably.

The whole work so far can not be considered—and is not considered by the association—as more than "the beginnings of a set of standard specifications." The story of its growth, however, awakens the utmost admiration for the painstaking manner in which the committee has proceeded. The material was first subdivided into classes, as indicated by the bulletins, the preparation of specifications for each class being confided to a separate sub-committee. A circular letter was then sent to the leading engineers, railroad companies, and manufacturers of the United States, requesting copies of their specifications, as a composite basis from which to start. Next followed the preparation and circulation of series of questions, drawing out further information, the compilation of reports, and the discussion of each specification in detail, item by item. After half a dozen meetings, the rough drafts were sent to all members of Committee No. 1, and after renewed discussion in the light of their general comment, the specifications were edited in the same general form and the tabular summaries of the specifications in general use (by which the bulletins are accompanied), were prepared. Each specification was then discussed again in detail, some minor changes were made, and all were printed for distribution as they now appear. The national engineering societies have been asked to take them up for discussion, and the entire American Section of the International Association, together with the leading engineers of the country, are invited to submit their criticisms at the autumn meeting of the association next October.

The chairman and secretary, Mr. Wm. R. Webster and Dr. Wm. H. Wahl, present their report with the modest conclusion: "What we really want to know is, are these fair representatives of specifications in use in this country, and the best American practice? If not, then what modifications are required to make them so?" Their labor should meet with the strongest encouragement, for national agreement is the first step toward the international agreement upon specifications and methods of testing which is most important in the growing expansion of international engineering trade.

Minerals of the Philippines.

Mr. George F. Becker, in *Scribner's*, touches briefly upon the mineral wealth of the Philippines, which was reviewed at length in these pages by Dr. David T. Day, chief of the division of statistics, U. S. Geological Survey, in May, 1899. While closely confirmatory of Mr. Day's summary, Mr. Becker throws additional light upon the gold resources of the islands, which on further study seem to diminish in importance. The natives are extremely skilful with the pan, he says, and "also understand 'salting' a mine."

They have been working the gravels for centuries, and even going into the quartz, and have probably left few prizes. Mr. Becker considers the "gold resources of the Philippines comparable with those of the Carolinas and Georgia, rather than with those of Colorado or California."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q* semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.

Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

See also Civil Engineering, Materials.

Arch.

See Roof Arches, below.

See also Arch and Masonry Arch, under Civil Engineering, Construction.

Church.

A Concrete Church. Illustrated description of a monolithic concrete church built by a wealthy congregation in Brooklyn, N. Y. 1000 w. Eng Rec—May 5, 1900. No. 33999.

Fireproof.

Fireproof Construction. Editorial, reviewing a recent work by J. K. Freitag—"The Fireproofing of Steel Buildings." 4000 w. Builder—April 28, 1900. No. 34049 A.

The Second Fire in the Horne Department Store at Pittsburg. Peter B. Wight. Describes the construction of the building after the first fire, and illustrates the damage, calling attention to the lessons of the second test. 2800 w. Br Build—May, 1900. No. 34419 C.

Foundations.

Foundations for Kingsbridge Power Station for the Third Avenue Railway, New York City. Illustrated description of a construction consisting of a concrete cap carried by piles. 800 w. Eng News—May 17, 1900. No. 34309.

Hippodrome.

The New Hippodrome at Paris (Le Nouvel Hippodrome). G. Leugny. A well-illustrated account of the construction of this building, particularly of the roof trusses. 1800 w. Revue Technique—April 25, 1900. No. 34478 D.

Hospitals.

The Requirements of Modern Hospitals (Ueber Bedürfnisse Moderner Krankenanstalten). Franz Berger. A general discussion of hospital construction and sanitation, with plans. 7000 w. Zeitschr d Oest Ing u Arch Ver—May 11, 1900. No. 34143 B.

Lightning Protection.

See Electrical Engineering, Miscellany.

Metal Protection.

The Theory and Practice of Protective Coatings for Structural Metal. A. H. Sabin. Describes experimental tests made on metal plates, the general effect of different paints, the way the paints are produced, composition of varnishes, etc. Discussion. 8000 w. Pro of Engs' Club of Phila—May, 1900. No. 34298 D.

Zinc a Protective Coating for Iron and Steel. Sherard Cowper-Coles. Abstract of paper read at meeting of Cleveland Inst. of Engs., England. Claims it is cheaper and more effective than painting, and describes the processes. Discussion. 2800 w. Col Guard—April 27, 1900. No. 34069 A.

Office Building.

The New Edison Building in Chicago. Describes and illustrates this fine building and its contents. 5400 w. W Elect'n—May 19, 1900. No. 34425.

The United Gas Improvement Company Office Building. Illustrated description of a fine building in Philadelphia, devoted entirely to the gas business. 1700 w. Pro Age—May 15, 1900. No. 34291.

Roof Arches.

The Newark Armory Drill Hall. Illustrated description of a drill-hall, having 163½ ft. 3-hinge roof arches containing several special features. The erection of the roof is also described. 1200 w. Eng Rec—May 26, 1900. No. 34435.

School.

Primary School House in Zurich (Das Primarschulhaus au der Klingenstrasse in Zürich—Kreis III.). A. Geiser. A short description, with illustration and plans. 500 w. Schweiz Bauzeitung—April 28, 1900. No. 34163 B.

Terra-Cotta.

The Manufacture of Terra-Cotta and Its Use as a Building Material. H. A. Webber. Follows the work through the factory, step by step, discussing its durability, cost, etc. 5500 w. Tech., No. 14—1899-1900. No. 34387 D.

HEATING AND VENTILATION.

Court-House.

Ventilation and Heating, Appellate Court House, New York. Illustrated description of a dual plant, one for operation during the hours when many parts of the building are liable to be crowded, and the other for the period from 5 P. M. to 6 A. M. 2700 w. Eng Rec—May 12, 1900. No. 34282.

Hospital.

Ventilating and Heating the City Hospital, Albany. Illustrated account of the special features of a large one-pipe system of heating by direct-indirect radiation, with a natural system of ventilation.

1800 w. Eng Rec—May 26, 1900. No. 34436.

Hot-Water Heating.

Hot-Water Heating from a Central Station. H. T. Yaryan. Illustrated description of the system of the Toledo Heating and Lighting Co. 3300 w. Trans Am Soc of Mech Engs, No. 852—May, 1900. No. 34093 C.

Mills.

Warming and Ventilation of Mills. A summary of the advice given by S. Horner Woodbridge for work of this sort. 2600 w. Eng Rec—May 5, 1900. No. 34001.

Steam Heating.

The Removal of Condensation Water in Low Pressure Steam Heaters (Die Kondenswasserableitung bei Niederdruck-Dampfheizungen). An illustrated general account, with particular description of the Poensgen apparatus. 800 w. Gesundh Ingenieur—April 30, 1900. No. 34160 B.

Warming.

Warming and Ventilation. T. Wilson Aldwinckle. Read before the London Arch't Assn. Discusses this subject in general, also mechanical and natural ventilation, and special ventilation and warming as applied to various classes of buildings. 5000 w. Builder—April 21, 1900. No. 33906 A.

PLUMBING AND GAS FITTING.

Swimming Bath.

The Wissahickon Heights Swimming Pool. Illustrated description of an 81 x 30-ft. pool used for summer bathing, built in a superior residence portion of Philadelphia. 1000 w. Eng Rec—May 26, 1900. No. 34434.

MISCELLANY.

Acoustics.

Architectural Acoustics — Reverberation; Rate of Decay of Residual Sound. Wallace C. Sabine. Illustrated explanation of the theory of the manner in which residual sounds die out in auditoriums, and its confirmation by experiments. 2500 w. Eng Rec—May 5, 1900. No. 34000.

Architectural Acoustics — Reverberation; Exact Solution. Wallace C. Sabine. A discussion of the physical principles which underlie the annoying reverberation in some rooms. 2500 w. Eng Rec—May 12, 1900. No. 34283.

Architectural Acoustics — Reverberation; the Absorbing Power of an Audience, and Other Data. Wallace C. Sabine. Gives the results of experiments to determine the effect of people and inanimate objects to prevent annoying reverberations in an auditorium, in terms of a sq. m. of open window surface. 3100 w. Eng Rec—May 19, 1900. No. 34337.

Architectural Acoustics — Reverberation; Calculation in Advance of Construction. Wallace C. Sabine. Illustrated description of the methods adopted in preparing plans for a large concert hall to avoid annoyance from reverberation. 2200 w. Eng Rec—May 26, 1900. No. 34437.

Laboratory.

The Physical-Chemical Laboratory of Giessen University (Das Physikalisch-Chemische Laboratorium der Grossherzoglich Hessischen Landes-Universität Giessen). Prof. K. Elbs. A description, with plans, of this new laboratory. 1800 w. Zeitschr f Elektrochemie—April 26, 1900. No. 34168 G.

Paris Exposition.

The Paris Exposition of 1900. C. L. Durand. An account of the opening ceremonies and a sketch of the main features of the electrical and mechanical sections. Ill. 8500 w. Elec Rev, N. Y.—May 2, 1900. No. 33966.

CIVIL ENGINEERING

BRIDGES.

Accident.

Accident to the Van Buren Street Bridge, Chicago. Description of an accident to the Scherzer bascule bridge over the Chicago River. The accident is supposed to have been caused by a defective casting. 800 w. Eng News—May 10, 1900. No. 34232.

Collapse of the Foot Bridge Leading to the "Celestial Globe" at the Paris Exposition (Effrondrement de la Passerelle du "Globe Céleste"). A short general description of the bridge, with plans; and photographs taken after the accident. 500 w. Génie Civil—May 5, 1900. No. 34185 D.

The Bridge Collapse in Paris. Comment on the collapse of the foot-bridge at the Paris Exhibition, and the strength of armored concrete. 1400 w. Engr, Lond. May 4, 1900. No. 34259 A.

Arch.

The Hingeless Arch. Discusses the

subject of stresses, including those due to changes of temperature. 1800 w. Engr, Lond—April 27, 1900. No. 34071 A.

The 3,820-ft. Stone Arch Bridge for the Pennsylvania R. R. at Rockville, Pa. Illustrated description of the general details of the longest stone arch railway bridge in the world. 700 w. Eng News—May 10, 1900. No. 34230.

See also Roof Arches, under Architecture, and Building, Construction.

See also Masonry Arch, under Civil Engineering, Construction.

Chain Bridge.

The Manufacture of the Chain Links for the Schwurplatz Bridge Over the Danube at Buda-Pesth (Die Herstellung der Kettenglieder für die Schwurplatz-Brücke über die Danau bei Budapest). Julius Seefehlner. An illustrated general account of this chain highway bridge, with details of the manufacture of the links. Serial. 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—May 5, 1900. No. 34107 D.

Concrete-Steel.

Concrete-Steel Construction in the Proposed Memorial Bridge. Illustrated description of the design of a 192-ft. arch, with practically all the tensile stresses taken by steel members hidden by concrete and cut-stone masonry. 1000 w. Eng Rec—May 26, 1900. No. 34429.

Iron Concrete Foot-Bridge at the Paris Exposition (Passerelle en Béton Armé Reliant le Pavillon de Madagascar au Trocadéro). Ch. Dautin. A short illustrated description of this bridge, constructed on the Hennebique system. 400 w. Génie Civil—May 12, 1900. No. 34189 D.

Design.

Artistic Design for a Movable Bridge. An ilustration of the possibilities of artistic and monumental design for this type. 600 w. Ry & Engng Rev—May 12, 1900. No. 34290.

Drawbridge.

Eight-Track Rolling-Lift Drawbridge Over the Chicago Drainage Canal. Illustrated description of the accepted design, with statement of the unusually complicated conditions. 1600 w. Eng News—May 24, 1900. No. 34411.

The Eight-Track Scherzer Rolling Lift Bridge at Chicago. Illustrated description of an 8-track span of 150 ft. on a 68-degree skew, designed as a fixed span for early service and subsequent modification into a bascule bridge, when the waterway below is open for boats. 1900 w. Eng Rec—May 26, 1900. No. 34430.

East River Bridge.

Erection of Towers of New East River Bridge. Illustrated description of the various methods employed in assembling the parts of these skeleton towers, which rise nearly 335 ft. above high water. 2900 w. Eng Rec—May 5, 1900. No. 33993.

The New East River Bridge Approaches. Illustrated description of the viaducts for the pedestrians, surface and elevated cars, carriages and bicyclists on the second suspension bridge between Manhattan and Brooklyn. 2500 w. Eng Rec—May 12, 1900. No. 34281.

The Third East River Bridge. Illustrated description of the plans for the third suspension bridge to be built between Manhattan and Brooklyn, New York. 700 w. Eng Rec—May 12, 1900. No. 34278.

Viaduct Approaches for the New East River Bridge at New York City. Illustrated description of typical structural details. 3000 w. Eng News—May 10, 1900. No. 34226.

Erection.

Some Recent Work of the Keystone Bridge Co., Near Pittsburg. Illustrates and describes the interesting engineering features and methods of construction. 2700 w. R R Gaz—May 18, 1900. No. 34347.

Germany.

German Bridge Building in the 19th Century (Der Deutsche Brückenbau im XIX. Jahrhundert). Prof, Georg Mehrtens. The first part of a very well illustrated history of iron and steel bridge construction, in theory and practice, written on the occasion of the German bridge exhibit at Paris. Serial. 1st part. 7000 w. Zeitschr d Ver Deutscher Ing—April 21, 1900. No. 34103 D.

Moving.

Moving a Bridge. From *La Nature.* Illustrations and particulars of a difficult piece of engineering work. 500 w. Sci Am Sup—May 26, 1900. No. 34407.

Railway Bridges.

The Great Northern Railway—Bridges Over the River Aire. Illustrated detailed description. 1800 w. Engr, Lond—April 20, 1900. No. 33919 A.

Rigid Suspension Bridge.

New Type of a Rigid Suspension Bridge (Nouveau Type de Pont Suspendu Rigide). Com. Gisclard. A general description, with diagrams, of a suspension bridge stiffened by two trusses hinged at the centre. 3500 w. Génie Civil—May 5, 1900. No. 34184 D.

Swing Bridge.

Rebuilding of the Kinnickinnic River Swing Bridge on the Chicago & Northwestern Railway, at Milwaukee, Wis. Frances H. Bainbridge. Illustrated detailed description of the work, with discussion. 6000 w. Jour W Soc of Engs—April, 1900. No. 33923 D.

Sydney Harbor.

Proposed Bridge at Sydney. A copy of terms and conditions for the construction of a bridge connecting Sydney with North Sydney. 1100 w. U. S. Cons Repts, No. 726—May 10, 1900. No. 34089 D.

Thomas Steel.

Report of Bridge Material Committee of the *Oesterr. Ingenieur und Architekten Verein,* on the Admissibility of the Use of Thomas Steel in Bridge Construction (Bericht des Eisenbrücken-Material-Ausschusses über die Zulässigkeit der Verwendung des Thomasflusseisens zu Brückenconstructionen). The full report, illustrated, recommending the use of Thomas steel when certain conditions are fulfilled. 20000 w. Zeitschr d Oest Ing u Arch Ver—April 27, 1900. No. 34141 B.

Discussion on the Report of the Bridge Material Committee of the *Oesterr. Ingenieur und Architekten Verein* (Zur Debatte über den Bericht des Eisenbrückenmaterial-Asschusses). Franz Kupelweiser A contribution to the discussion on the report mentioned above. 3000 w. Zeitschr d Oest Ing u Arch Verein—April 13, 1900. No. 34137 B.

Viaducts.

Bifurcated Viaduct Approaches in Nashville, Tenn. Illustrated description of the plan of construction adopted. 1000 w. Ry & Engng Rev—May 26, 1900. No. 34444.

The Piney Branch Viaduct, Washington, D. C. Thomas C. J. Baily. Illustrated description of the main features. 1000 w. Eng News—May 17, 1900. No. 34317.

Vienna.

The New Franzens Bridge Over the Danube Canal in Vienna (Die Neue Franzensbrücke über den Danaucanal in Wien). Franz Pfeuffer. A very fully illustrated description of this ornamental highway bridge and its construction. 3 plates. 6000 w. Zeitschr d Oest Ing u Arch Ver—May 4, 1900. No. 34142 B.

CONSTRUCTION.

Arches.

Concrete Arches. Daniel B. Luten. An account of further experiments by the writer upon small model arches of neat Portland cement, bringing out points of interest in design. 3000 w. R R Gaz—May 11, 1900. Serial. 1st part. No. 34238.

See also Masonry Arches, below, and Roof Arches, under Architecture and Building, Construction.

Contracting Methods.

Modern Contracting Methods. Lessons for quarry men from the rock work of the Chicago canal and the New York subway. Gives illustrated description of appliances and methods. 3000 w. Stone—May, 1900. No. 34300 C.

Culverts.

Cement-Concrete Culverts. A. W. Campbell. From a paper read before the Assn. of Ontario Land Surveyors. Concerning the cost, the care needed in mixing and selection of materials, etc. 1500 w. Can Engr—May, 1900. No. 34274.

Docks.

The New South Dock at Cardiff. Illustrated description of work now in progress. 1400 w. Transport—April 27, 1900. No. 34050 A.

Masonry Arch.

The Bear Valley Dam as an Arch. J. M. Alarco. Investigates the only arch dam in the United States, located in San Bernardino Co., California. Ill. 1300 w. Tech, No. 14—1899-1900. No. 34389 D.

The Bourbonnais Railway Arch. C. L. Eddy. A test of the different theories of the masonry arch by applying them to an arch which for years has successfully carried a heavy railroad traffic. 1500 w. Tech, No. 14—1899-1900. No. 34386 D.

Pile-Driving.

On Pile-Driving Machines. F. J. Rowan. A survey of various machines for driving piles, with discussion. Ill. 9000 w. Trans of Inst of Engs & Shipbuilders in Scotland—Feb. and March, 1900. No. 34324 each D.

Roads.

Fallacies in Good-Road Economics. Ira O. Baker. Discusses wagon transportation, and the real advantages of good roads. 5800 w. Tech, No. 14—1899-1900. No. 34381 D.

The Improvement of Our Roads. A. Moresby White. Reviews the Highway Acts of Great Britain; discusses the construction of roads; repairing, and various improvements. General discussion. 8000 w. Jour Soc of Arts—May 11, 1900. No. 34365 A.

Simplon Tunnel.

Simplon Tunnel (Simplon-Tunnel). Abstract of the Jura-Simplon R. R. Co.'s report for the quarter ending March 31, 1900, giving general figures and tables showing the progress of the work in various ways. 1500 w. Schweiz Bauzeitung—May 12, 1900. No. 34166 B.

HYDRAULIC AND WATER SUPPLY.

Contamination.

Algæ as a Cause of the Contamination of Drinking Water. G. T. Moore, in the *Amer. Jour. of Pharmacy.* Information concerning this group of plants, which produces more trouble than any other members of the vegetable kingdom. 3800 w. San—May, 1900. No. 34016 D.

Dam Accidents.

Accident to the Partially Built Dam of the Denver Union Water Co. Views and particulars of the structure and accident. 500 w. Eng News—May 17, 1900. No. 34313.

More Light on the Failure of the Austin Dam. Thomas U. Taylor. Facts explaining some discussed points and discussion of the cause of the break and the possible solutions of the problem of water and lights. 2000 w. Eng News—May 10, 1900. No. 34228.

Some Considerations Regarding the Failure of the Austin Dam. An editorial discussion on the importance of making a perfect jointure between the base of a dam and the bed rock. 1000 w. Eng Rec—May 26, 1900. No. 34427.

The Austin Dam Failure. Letter from C. Baillairge urging the construction of dams and retaining walls of a thickness equal to their height. 1100 w. Eng Rec—May 19, 1900. No. 34338.

The Failure of the Austin Dam. William von Rosenberg, Jr. Illustrated description of the erosion of the river bed at the toe of a 60-ft. masonry dam, subsequently washed away. 900 w. Eng Rec—May 19, 1900. No. 34332.

Dams.

The Reconstruction of Big Hole Dam. Jos. H. Harper. A review showing the weak points in the old structure, the means proposed for strengthening it, features in which the rebuilding differed from the original work, and considerations that influenced the designs and controlled the work. Discussion. Ill. 6500 w. Jour Assn of Engng Socs—April, 1900. No. 34408 C.

Building an Impounding Dam for Storage Reservoir for the Consolidated Gold Fields, Johannesburg, South Africa. Frank B. Knight. Illustrated description of interesting mechanical appliances. 900 w. Mines & Min—May, 1900. No. 34006 C.

Mine Dams. James McNaughton. Read before the Lake Superior Min. Inst. Describes how they are built to withstand heavy pressures in the iron-mining district of Michigan. 2000 w. Mines & Min—May, 1900. No. 34009 C.

The Lagrange Dam, California. E. H. Barton. Detailed description of the dam and its construction. 2200 w. Trans Am Inst of Min Engs—Sept., 1899. No. 34032 D.

Docks.

The Thames Docks. An editorial explanation of their unsatisfactory condition and the problems to be solved. 2500 w. Engng—May 18, 1900. No. 34465 A.

Drainage.

Drainage of the Valley and City of Mexico. Willis B. Wright. Historical review of the drainage of the city, and description of the new drainage and sewerage systems under construction. Map. 2200 w. Jour Assn of Engng Socs—April, 1900. No. 34409 C.

The Drainage and Protection of the Philadelphia Lowlands. Harrison Souder. Illustrated description of these lands and the methods used. Discussion. 4000 w. Pro of Engs' Club of Phila—May, 1900. No. 34299 D.

Drainage Canal Difficulties. Hearing of the vessel interests and Chicago representations by the Sec. of War. 2500 w. Marine Rev—May 24, 1900. No. 34420.

Dredging.

Deep Sea Dredges and Dredging. Waldon Fawcett. Illustrated description of sea-going vessels that can dredge and dump 9,000 tons of sand a day. 1700 w. Am Mfr & Ir Wld—May 24, 1900. No. 34424.

Electrolysis.

Electrolysis in Peoria. Dabney H. Maury. Abstract of a paper before the Richmond convention of the Am. Water-Works Assn., on the damage done to pipes and standpipes by current from electric railways. 1700 w. Eng Rec—May 19, 1900. No. 34331.

Filter Crib.

The Filter Crib of the Allegheny Water Works. Illustrated description, with information concerning the construction and working. 900 w. Eng News—May 17, 1900. No. 34312.

Filtration.

Filtration of the Washington Water Supply. Reviews the experiments made to ascertain the best method of removing the high bacteria and turbidity characteristics of the Potomac River water, which led to a recommendation to build a mechanical filter plant. 3000 w. Eng Rec—May 12, 1900. No. 34280.

Iron as a Coagulant for Mechanical Filters. Review of a paper by Dow R. Gwinn before the Am. Water Wks. Assn., on the methods used for coagulation at Quincy, where the raw water does not have sufficient carbonate of lime to allow the use of sulphate of alumina. 1000 w. Eng Rec—May 19, 1900. No. 34376.

The Norfolk Mechanical Filter Plant. Review of a paper by E. B. Weston before the Am. Water Wks. Assn. on an 8,000,000-gal. plant for the removal of color and turbidity from a swampy water. The coagulation and sedimentation take place in a reservoir outside the filter house, instead of in the sedimentation chambers of each filter tank. 1800 w. Eng Rec—May 19, 1900. No. 34334.

The Removal of Iron from Water by

the Linde-Hess Process (Die Wasser-Enteisenung nach dem Verfahren von H. v. d. Linde und Dr. C. Hess). An illustrated description of this process, in which there is a filter, filled with sawdust impregnated with zinc oxide. 1500 w. Gesundh Ingenieur—April 15, 1900. No. 34157 B.

Flow.

A New Hydraulic Criterion. A statement of a simple test of the accuracy of experiments on the flow of water in channels, and of its use to detect errors in results otherwise not noticeable. 900 w. Eng Rec—May 5, 1900. No. 33992.

On the Flow of Water Over Dams. Discussion of paper by George W. Rafter. 7700 w. Pro Am Soc of Civ Engs—May, 1900. No. 34396 E.

Harbor Improvements.

Removal of Rocks in San Francisco Harbor. Illustrated description of one of the largest enterprises of this kind on record. 1100 w. Min & Sci Pr—May 12, 1900. No. 34293.

Removing Submerged Rock in San Francisco Harbor. Illustrated description of a drilling platform, hung like a derrick arm from a gin post erected on top of the rocks to be blasted; the drills were of the oil-well type. 600 w. Eng Rec—May 26, 1900. No. 34431.

The Story of the Savannah Harbor Work. Eeditorial review of the work on which Capt. Carter was engaged, and the evidence upon which he was pronounced guilty. 4800 w. Eng News—May 10, 1900. No. 34227.

Irrigation.

Irrigation Studies. Elwood Mead. Extracts from the report of the U. S. Dept. of Agriculture, concerning methods of distributing and using water in irrigation. 6600 w. Pro Am Soc of Civ Engs—May, 1900. No. 34394 E.

Irrigation Works on the Nile. An illustrated account of the progress made in the great engineering work of constructing the Assouan dam and reservoir. 2200 w. Engr, Lond—May 11, 1900. Serial. 1st part. No. 34369 A.

Isthmian Canal.

Difference of Opinion on an Isthmian Canal. Gives opinions expressed by Jas. D. Phelan, and by C. P. Huntington. 1800 w. Ry & Engng Rev—May 19, 1900. No. 34354.

Silico Lake Railway, and the Greytown Breakwater of the Nicaragua Canal Co. Illustrated descriptions furnishing facts of interest bearing on the construction of the Nicaragua Canal. 450 w. Eng News—May 17, 1900. No. 34316.

Locks.

The Hotopp Syphon Locks on the Elbe-Trave Canal. Illustrated detailed description of the locks and their operation. 3000 w. Engng—May 4, 1900. No. 34246 A.

Mains.

Repairing a 30-Inch Submerged Water Main. D. W. French. Abstract of paper before the Am. Water Wks. Assn., describing the lifting of the pipe from a temporary pile trestle and substituting new lengths for those broken. 1700 w. Eng Rec—May 19, 1900. No. 34333.

Nicaragua.

See Isthmian Canal, above.

Panama.

See Isthmian Canal, above.

Pipe Coatings.

Asphalt Coatings for Water Pipe. Information concerning the material known as "mineral rubber" asphalt. 1300 w. Eng News—May 17, 1900. No. 34315.

Rainfall.

Rainfall in Cities Considered with Reference to the Design of Sewers (Ueber die den Stadt Entwässerunganlagen zu Grunde zu Legenden Regenmengen mit Besonderer Berücksichtigung der Verzögerung im Abflusse derselben). Ed. Bodenseher. A very complete treatment of the subject, paying special attention to the retardation of the flowing off of rain water from the surfaces on which it falls. Tables and diagrams. 7500 w. Zeitschr d Oest Ing u Arch Ver—April 20 1900. No. 34138 B.

Richmond, Va.

Richmond's Model Water System. An illustrated detailed description of the municipal plant. 2000 w. Fire & Water—May 12, 1900. No. 34276.

Sault Ste. Marie.

The Sault Power Canal. Waldon Fawcett. An illustrated account of this project, which will supply an immense amount of power, rivaling Niagara. 1400 w. Sci Am—May 26, 1900. No. 34405.

Stand-Pipes.

The Failure of the Stand-Pipe at Elgin, Ill. William D. Pence. An illustrated account, giving information relative to the stand-pipe and its failure, with discussion of the cause. Also other reports. 5500 w. Eng News—May 3, 1900. No. 33975.

Syracuse.

Syracuse Water Supply. James H. Hamilton. Reviews the benefits derived from municipal ownership. 3500 w. Munic Af—March, 1900. No. 34245 C.

Water Meters.

Experience with Water Meters at Lexington, Ky. Abstract of paper before the Am. Water Wks. Assn., by S. A. Charles, describing the operation of the meter system in a city with 99 per cent. of the services metered. 800 w. Eng Rec—May 19, 1900. No. 34335.

Water Purification.

Mechanical Filtration, Vincennes, Indiana. Illustrated description of a plant of 2,000,000 gals. daily capacity, containing a number of new features for controlling the operations and washing the sand. 1800 w. Eng Rec—May 5, 1900. No. 33995.

Water Purification at Vincennes, Ind. Illustrated description of this plant, with statement of the conditions to be met. 2500 w. Eng News—May 3, 1900. No. 33978.

Water Storage.

Water-Storage Systems at Fort Terry and Lacona. Illustrated description of two small works noteworthy for the use of tanks under air pressure as a substiture for standpipes. 900 w. Eng Rec—May 26, 1900. No. 34433.

Waterway.

A Proposed Waterway from Lake Michigan to the Mississippi River. Extract from the memorial submitted to Congress favoring the construction of this waterway by the Federal government. Also a project to enlarge the Illinois and Michigan canal is discussed. 2800 w. Eng News—May 3, 1900. No. 33976.

Water-Works.

Recent Events at the Castlewood Dam. Illustrated description of the heavy flow of water through a rock-fill dam 70 ft. high without washing it out. 1400 w. Eng Rec—May 19, 1900. No. 34330.

Wells.

Protection to Well-Water Supply. H. Etheridge. Illustrates and describes a device for straining water filtered through sand, and thus overcoming the destructive effects on machinery. 900 w. Fire & Water—May 12, 1900. No. 34277.

MATERIALS.

Building Stones.

Building and Ornamental Stones of Texas. From late reports of E. T. Dumble. Information concerning valuable deposits. 1800 w. Stone—May, 1900. No. 34301 C.

Cement.

Plant of the Lawrence Cement Company of Pennsylvania. Illustrated description of Portland cement works recently started near Siegfried, Pa., where particular attention was paid to the arrangement of the machinery and the plans for handling the materials, so as to avoid the use of labor as far as possible. 4800 w. Eng Rec—May 12, 1900. No. 34279.

Slag Adulteration of Portland Cement. Halbert L. Chipps. A brief account of experimental investigations. 800 w. Tech. No. 14—1899-1900. No. 34385 D.

The Cement Age. G. W. Percy. Historical review of the use and manufacture of cement, its endurance and remarkable qualities. 5000 w. Jour Assn of Engng Socs—April, 1900. No. 34410 C.

The Influence of the Rotary Kiln on the Development of Portland Cement Manufacture in America. Interesting discussion of the cause of the United States' slow development in the manufacture of cement, and then the rapid development all at once, with much information. 3000 w. Eng News—May 3, 1900. No. 33977.

The Manipulation of Cement Tests. A review of the replies received by a special committee of the Am. Soc. C. E. to a circular letter for information concerning the best methods of making cement tests. 3300 w. Eng Rec—May 5, 1900. No. 33997.

Cement Walks.

Letters to the Editor Concerning Cement Walks. A discussion of the causes of failure in such walks and suggested remedies. 2700 w. Eng Rec—May 12, 1900. No. 34284.

Metal Protection.

See Architecture and Building.

Steel Specifications.

See Mining and Metallurgy, Iron and Steel.

Timber Preservation.

A Proposed Method for the Preservation of Timber. F. A. Kummer. Describes experiments made with a view of improving the creosoting process. 4400 w. Pro Am Soc of Civ Engs—May, 1900. No. 34393 E.

Preservative Treatment of Timber. O. Chanute. Information concerning the processes tried and results attained; the work as carried on in Europe, and the processes in vogue. Discussion. 15500 w. Jour W Soc of Engs—April, 1900. No. 33922 D.

MUNICIPAL.

Bacteria.

The Utilization of Bacteria and Bacteriological Methods in Sanitary Engineering. A. C. Abbott. Calls attention to various devices favoring the application of this process in the purification of water-supply and the disposal of waste. 6800 w. Pro of Engs' Club of Phila—May, 1900. No. 34296 D.

Garbage Crematory.

The Thackeray Garbage Furnaces at San Francisco, Cal. F. J. Mills. Illustrated description of the largest single plant for burning garbage in the United States, and possibly in the world, with editorial comment. 4700 w. Eng News—May 17, 1900. No. 34310.

Municipal Supply.

Municipal Light, Heat, and Power. Alton D. Adams. A comparison of the results obtained by gas and electric energy. 2700 w. Munic Engng—May, 1900. No. 33925 C.

Paris.

Paris From a Sanitary Engineering Standpoint (Die Stadt Paris vom Gesundheitstechnischen Standpunkte). Hermann Beraneck. A general account, with some details of the sewage, water supply, street cleaning, etc., and two plans. 4000 w. Zeitschr d Oest Ing u Arch Verein—April 27, 1900. No. 34140 B.

Pavements.

Pavements and Vitrified Brick in Washington, D. C. Discusses asphalt and vitrified brick as materials for paving. 2000 w. Brick—May 1, 1900. No. 34077.

Paving Tests.

Asphalt Paving Tests. F. E. Puffer. Explains simple tests that may be undertaken by city engineers. 1000 w. Munic Engng—May, 1900. No. 33924 C.

Rapid Transit.

Contracts and Quantities in the New York Rapid Transit Railway Work. Editorial giving figures showing the enormous quantity of engineering material to be consumed in carrying out this great project. 2200 w. Eng News—May 24, 1900. No. 34413.

Sewage Disposal.

Sewage Treatment at Acton, England. James H. Fuertes. Illustrated description of a plant for a town of 7,000 people, where ferozone is used as a coagulant and polarite as a filtering material. 600 w. Eng Rec—May 5, 1900. No. 33994.

Sewage Disposal at Mendota, Ill. Illustrated description of the first system of intermittent filtration in the State, with a summary of the chemical analyses of sewage and effluent. 900 w. Eng Rec—May 26, 1900. No. 34432.

Sewerage.

Apportioning the Expenses of Joint Sewerage Works. A review of a method like that of clearing house settlements, making each part-owner of the works pay in proportion to the amount of sewage and ground water contributed, and its advantage in location. 1000 w. Eng Rec—May 26, 1900. No. 34428.

Operation of the Berlin Sewerage System and Sewage Farms for the Year 1898-9. Allen Hazen. Abstract from *Verwaltungs-Bericht des Magistrats zu Berlin.* 700 w. Eng News—May 24, 1900. No. 34414.

The New Sewerage and Sewage Disposal Works of the Borough of Southampton. W. B. G. Bennett. A description of the new works, with map. Also discussion. 6800 w. Jour San Inst—April, 1900. No. 34241 E.

Street Cleaning.

Street Cleaning in Dresden (Die Strassenreinigung Dresdens). A general account of methods and results. 2500 w. Gesundh Ingenieur—April 15. 1900. No. 34158 B.

MISCELLANY.

Engineering Competition.

American and British Industries (L'Industrie Américaine et l'Industrie Anglaise). E. Biard. A review of the recent discussion in *Engineering*, from a French standpoint, with curves and tables. 12000 w. Bull de la Soc d'Encour—April 30, 1900. No. 34179 G.

Graphical Methods.

A Graphical Method for Calculating the Flat Base Frame of Framework Structures (Graphische Methode der Berechnung des Flachen Fussringes Räumlicher Fachwerke). Prof. Felix Jasinski. A mathematical article, with numerous diagrams. 2500 w. Schweiz Bauzeitung—May 5, 1900. No. 34164 B.

Graphical Solutions of Certain Problems in Engineering. F. H. Hummel. Abstract of a paper read at the meeting of the Soc. of Civ. and Mech. Engs. Deals with problems where the reasoning may be assisted and the results obtained by graphic constructions. 2200 w. Prac Engr—April 20, 1900. No. 33907 A.

Manchuria.

Russia's Opening for Anglo-Saxon Enterprise in Asia. A. H. Ford. Personal observations of the startling railway developments of Eastern Asia, the markets for machinery and engineering construction there afforded, and the rising competition of Japan. 4500 w. The Engineering Magazine—June, 1900. No. 34492 B.

Surveys.

Recent Stadia Topographic Surveys. Notes Relating to Methods and Cost. Discussion of paper by William B. Landreth. 7000 w. Pro Am Soc of Civ Engs—May, 1900. No. 34395 E.

Transition Curves.

Railway Transition Curve Tables for Field Use. F. K. Vial. Describes short methods for developing curve tables for field use for the several transition curves and explains their application to special field problems. 3800 w. Tech. No. 14—1899-1900. No. 34391 D.

Uniform Chord Length Method for the Railway Transition Spiral. Arthur N. Talbot. Describes method and presents a general table. 1600 w. Tech. No. 14—1899-1900. No. 34392 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Boiler Telegraph.

Electric Boiler Telegraph (Elektrischer Kesseltelegraph). An illustrated description of a Siemens-Halske apparatus for sending various signals to and from the boiler room of a ship. 800 w. Elektrizität—April 14, 1900. No. 34173 C.

Cables.

Construction of a Trans-Pacific Cable. Presents the arguments against a government-owned cable, and favorable to private ownership; also arguments against private control. 2300 w. Marine Rev—May 3, 1900. No. 33986.

Special Apparatus for Testing Cables Rapidly and Accurately. Henry W. Fisher. Illustrates and describes a set of cable-testing apparatus embodying insulation by direct reflection, electrostatic capacity by throw, and conductor resistance by Wheatstone bridge. 2500 w. Elec Wld & Engr—May 12, 1900. No. 34287.

Some Aspects of the Pacific Cables Question. Frederick Trimmer. Presents some features of interest from the American point of view, and others from foreign standpoints, mostly of the business aspects. 1500 w. Elec Wld & Engr—May 26, 1900. No. 34421.

Space Telegraphy.

Wireless Telegraphy. W. L. Howard. Reviews the Preece system and the Marconi system, and the trials in the U. S. navy. Ill. 3200 w. Marine Rev—May 17, 1900. No. 34319.

Specifications.

Pole Line Specifications of the Federal Telephone Company, of Pittsburg, Pa., for Use When Contracting for the Construction of Telephone Trunk or Toll Lines. Prepared by F. J. Dommerque and Fred. de Land. 3500 w. Tel Mag—May, 1900. Serial. 1st part. No. 34446.

Telegraph-Telephone.

Simultaneous Telegraphy and Telephony. F. Walloch, in *Elektrotechnische Zeitschrift.* Illustrated description of a system used in the Berlin Fire Department. 1800 w. Tel Mag—May, 1900. No. 34447.

Telephone Cut-Out.

The Use of the Blut Automatic Cut-Out Apparatus in Connecting Local Stations with the Main Lines of the German Telephone System (Einrichtung von Nebenstellen im Anschluss an die Fernsprechapparate der Reichspost unter Verwendung von Automatischen Sperrvorrichtungen System Blut). H. Blut. Paper read before the *Elektrotechnischer Verein,* giving an account of this semi-automatic apparatus, with illustrations. 4500 w. Elektrotech Zeitschr—April 19, 1900. No. 34111 B.

Telephones.

Interior Telephone Systems. W. S. Henry. Illustrates and describes systems that may be used for house, office, or factory buildings. 2300 w. Am Elect'n—May, 1900. Serial. 1st part. No. 33941.

The Telephoning of London by the Post Office. Particulars of the areas to be served and the exchanges to be established, the cables, conduits, manholes, switchboards, and method of working to be adopted. Ill. 1300 w. Elec Rev, Lond—May 11, 1900. Serial. 1st part. No. 34361 A.

Municipal Telephone in Amsterdam. Ph. Falkenburg and J. H. van Zanten. An account of a successful example. 1800 w. Munic Af—March, 1900. No. 34242 C.

Toll Lines.

Toll Lines, Their Construction, Equipment and Operation. W. T. Heddon. Discussion of the best practice. Ill. 2200 w. Tel Mag—May, 1900. No. 34448.

DISTRIBUTION.

Equalizers.

Voltage Equalizers for Three-Wire Systems. F. S. Hickok. Considers the necessity for such devices and the conditions which have influenced their development, giving a description of various methods that have been tried. 3200 w. W Elect'n—May 5, 1900. No. 34091.

Paris Exposition.

Distribution of Electrical Energy at the Paris Exposition (Fourniture de l'Energie Electrique Necessaire aux Divers Services et aux Installations Particulières). J. A. Montpellier. A general description, with some of the Exposition rules and regulations. 1400 w. Electricien—April 28, 1900. No. 34196 B.

Distribution of Electrical Energy and Electric Lighting at the Paris Exposition (Distribution de l'Energie Electrique dans l'Enciente de l'Exposition. Eclairage des Palais et des Jardins). Emile Cayla. An illustrated general description. 1 plate. 3000 w. Génie Civil—May 5, 1900. No. 34183 D.

Rotaries.

Rotary Converters. Hans Sigismund

Meyer. Translated from *Elektrotechnische Zeitschrift.* On the practical applications of these machines. 2500 w. Elec Eng, Lond—May 4, 1900. No. 34268 A.

Switch.

High Tension Cut-Out Switch, of Spreches (Hochspannungsausschalter von Sprecher). An illustrated description of a switch for high tension currents, constructed on the principle of a Siemens-Halske lightning arrester. 600 w. Elektrizität—April 28, 1900. No. 34175 C.

Wire Protection.

The Protection of Insulated Wires for Electric Light and Power Inside Buildings. Sydney F. Walker. Considers the requirements and how they may best be fulfilled. 2500 w. Elec Rev, Lond—May 4, 1900. Serial. 1st part. No. 34272 A.

Wiring.

One or Two-Wire Systems of Electric Distribution, Comparatively Discussed. Alton D. Adams. A discussion of the advantages of both systems, showing that the preference for the two-wire insulated circuits on ships seems to be well founded. 3000 w. Marine Engng—May, 1900. No. 34043 C.

The Electric Wiring of Buildings. W. A. Charmen. Considers wiring systems and general arrangements. Also discussion. Ill. 19500 w. Trans Inst of Engs & Shipbuilders in Scotland—Feb., March and April, 1900. 3 parts. No. 34325 each D.

Wiring Tables.

The Theory of the Wiring Table. Thomas G. Grier. An explanation, with illustrations of the application. 1700 w. Min & Sci Pr—April 28, 1900. No. 33983.

ELECTRO-CHEMISTRY.

Accumulators.

Gas Polarization in the Lead Accumulator (Ueber die Gaspolarisation im Bleiakkumulator). W. Nernst and F. Dolezalek. A short discussion of the subject. 900 w. Zeitschr f Elektrochemie—May 10, 1900. No. 34170 G.

The Temperature Coefficients of Lead Accumulators (Ueber den Temperaturkoeffizienten des Blei-Akkumulators). F. Dolezalek. An experimental research, with tables and curves. 1200 w. Zeitschr f Elektrochemie—April 19, 1900. No. 34169 G.

See also Mechanical Engineering, Automobiles.

Copper.

Some Practical Points in the Electro-Deposition of Copper. Alfred F. Bawtree. Read before the students of the Finsbury Tech. College. Discusses the fundamental principles of deposition, and phenomena observed. 1300 w. Elec Rev, Lond—May 11, 1900. No. 34362 A.

Electrolysis.

See under Street and Electric Tramways.

Silicon.

Metalloid (Metalloide). A description of a process, patented in Germany, for the electrolytic production of silicon from a mixture of carborundum and silica. 1000 w. Zeitschr f Elektrochemie—April 19, 1900. No. 34167 G.

ELECTRO-PHYSICS.

Cathode Rays.

Application of Cathode Rays to the Study of Variable Magnetic Flux (Application des Rayons Cathodiques à l'Etude des Flux Variables). M. Aliamet. An illustrated description of Prof. Augström's method of studying changes in a magnetic field by means of its effects upon a cathode discharge 1000 w. Electricien—May 5, 1900. No. 34199 B.

Impedance.

The Impedance of Circuits Having Mutual Induction (Ueber Richtungswiderstände bei Stromkreisen mit Gegenseitiger Induktion). Josef Herzog and Clarence P. Feldman. A theoretical discussion, with diagrams and formulæ. 600 w. Elektrotech Zeitschr—April 19, 1900. No. 34109 B.

Interrupters.

Irregularities in the Operation of the Recent Liquid Interrupters (Die Unregelmässigkeit der Unterbrechungen bei den Neueren Flüssigkeitsunterbrechern). Ernst Ruhmer. A mutoscopic investigation of the operation of Wehnelt and Simon interrupters, with illustrations and curves. 1800 w. Elektrotech Zeitschr—April 26, 1900. No. 34114 B.

The Indications of Commercial Instruments on Wehnelt Interrupter Circuits. George T. Hanchett. An account of experiments made and conclusions reached, showing how deceptive are measuring instruments, and explaining the conditions in a direct-current circuit including a Wehnelt interrupter. 2500 w. Elec Wld & Engr—May 5, 1900. No. 34027.

Long Sparks.

Apparatus for the Production of Powerful Electrical Effects at the Paris Exposition (Exploseur Rotatif et Dispositifs Divers pour la Production de Puissants Courants à Haute Frequence). A. d'Arsonval. Description of apparatus for producing decorative effects on the façade of the Electricity Building. 1500 w. Electricien—May 5, 1900. No. 34198 B.

Radiation.

Negative Electrification of the Secondary Rays Produced by Means of Röntgen Rays (Electrisation Negative des Rayons Secondaires Produits au Moyen des Rayons Röntgen). P. Cunie and G. Sagnac. A communication to the French Academy describing experiments which show the negative electrification of the secondary rays, with illustrations. 700 w. Comptes Rendus—April 9, 1900. No. 34193 D.

Note on the Transmission of the Radiation from Radium through Bodies (Note sur la Transmission du Rayonnement du Radium au Travers des Corps). H. Becquerel. A communication to the French Academy reviewing some experiments and discussing hypotheses. 1500 w. Comptes Reudus—April 9, 1900. No. 34190 D.

The Duration of the Emission of Röntgen Rays (Sur la Durée d'Emission des Rayons Röntgen). Bernard Brunhes. A communication to the French Academy describing experiments modeled on those of Wheatstone, by which the duration of emission is found to be of the order of one ten-thousandth of a second. 900 w. Comptes Rendus—April 9, 1900. No. 34191 D.

The Reflection and Refraction of Cathode Rays and of Deviable Radium Rays (Sur la Réflexion et la Réfraction des Rayons Cathodiques et des Rayons Déviables du Radium). P. Villard. A communcation to the French Academy describing experiments which seem to confirm J. J. Thomson's hypothesis of a secondary emission. 600 w. Comptes Rendus—April 9, 1900. No. 34192 D.

GENERATING STATIONS.

Boilers.

Boilers for Electric Power Plants. R. A. Douglass. Calls attention to things to be considered in deciding the question. 3400 w. Am Elect'n—June, 1900. No. 34451.

Boston Station.

The Boston Electric Light Company's Central Station. Illustrated description of a modern steam driven plant, distributing direct current for series arc lighting and alternating current for incandescent lighting and power purposes. 4000 w. Elec Rev, N. Y.—May 16, 1900. No. 34344.

Coal Handling.

Handling Coal in Central Stations. James Francis. Considers plants of more than 2000 h. p. output; those of 500 to 2000 h. p. output; and plants of less than 500 h. p. output, describing and illustrating various systems. 2200 w. Am Elect'n—June, 1900. No. 34453.

Chicago.

The Central Station Situation in the City of Chicago. Illustrated description of the arrangements for lighting the city and suburban districts, especially discussing the latter. Also editorial. 8800 w. Elec Wld & Engr—May 19, 1900. No. 34342.

Dynamo.

Siemens-Halske 2000 Kilowatt Rotary-Current Dynamo at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. — Drehstrommaschine von 2000 K. W. von Siemens & Halske A.-G.). An illustrated account of this machine with stationary armature and rotating field, directly coupled to a Borsig engine. 700 w. Elektrotech Zeitschr—May 3, 1900. No. 34117 B.

The 3000 Horse-Power Steam Dynamo of the Helios Company (Die 3000 PS. Dampfdynamo des Helios Elektricitäts-Aktiengesellschaft in Köln-Ehrenfeld). Dr. M. W. Hoffmann. A well illustrated description of this great rotary current generator, exhibited at Paris. 1400 w. Glaser's Annalen—May 1, 1900. No. 34122 D.

Progress in Dynamo Construction (Neuerungen im Bau von Dynamomaschinen). A review of the present state of the art, taking up the various parts of the machine in order. Serial. 1st part. 1600 w. Elektrizität—April 28, 1900. No. 34177 C.

Automatic Regulation of a Dynamo by Varying the Air Space (Dynamomaschine mit Selbstthätiger Regelung durch Verändern des Luftraumes). An illustrated description of a dynamo with field magnets whose distance from the armature can be varied. 800 w. Elektrizität—April 14, 1900. No. 34172 C.

Electrical Equipment.

Electrical Equipment for Small Central Stations. L. B. Mather. Discusses various arrangements for varying conditions. 2200 w. Am Elect'n—June, 1900. No. 34457.

Engines.

The Selection of an Engine for a Power Station. R. C. Carpenter. A discussion of types, with the conclusion that it is probable that the compound condensing engine is the type best adapted for power-house work under present conditions. 1800 w. Am Elect'n—June, 1900. No. 34450.

Foundations.

Foundations for Electrical Machinery. P. I. Panamolo. The importance of substantial foundations and the disastrous results from settling. Ill. 1500 w. W Elect'n—April 28, 1900. No. 33959.

German Station.

A Modern German Station. John R. Dick. Illustrates and describes the municipal station at Dortmund. 1800 w. Elect'n, Lond—May 4, 1900. Serial. 1st part. No. 34270 A.

Induction Motors.

Some Points About Induction Motors. W. T. Morrison. Facts as to current, etc., showing what can be expected of these motors. Ill. 1600 w. Am Elect'n —June, 1900. No. 34458.

Paris Exposition.

The Electric Plant on the Champ de Mars (Installation des Groupes Electrogènes au Champ-de-Mars). Emile Cayla. An illustrated general description of the electric generating plant at the Exposition. 2000 w. Génie Civil—April 21, 1900. No. 34180 D.

Electric Light and Power at the Paris Exposition. Illustrated description of the electricity building, generating plant and general arrangements. 6000 w. Elec Wld & Engr—May 19, 1900. No. 34343.

The Power Generating Plant at the Paris Exposition Comprising Typical Examples of European Engineering. Illustrated detailed description. 4000 w. Am Elect'n—June, 1900. No. 34449.

Piping.

The Arrangement of Central-Station Piping. William D. Ennis. Considers the arrangement in a small lighting plant, and also for a 500 h. p. station. Ill. 3000 w. Am Elect'n—June, 1900. No. 34455.

Reconstruction.

Extension and Reconstruction of Central Stations and Distributing Systems. Peter Junkersfield. Considers some of the latest developments in central station work in the United States, particularly with reference to extension and reconstruction of existing plants. 5400 w. Tech, No. 14—1899-1900. No. 34382 D.

Stoking.

Stoking in Central Stations. James F. Hobart. Illustrates and describes some of the best known types of mechanical stokers. 1800 w. Am Elect'n—June, 1900. No. 34452.

Switzerland.

The Electric Plant of the *Société des Forces Motrices de l'Avançon* in Bex, Canton Waadt (Das Elektricitätswerk der Société des Forces Motrices de l'Avançan in Bex, Waadt). K. A. Breüer. A well illustrated account of this plant, which gets power from the Avançon River, and distributes light and power and operates a tramway. Serial. 1st part. 1500 w. Schweiz Bauzeitung—April 14, 1900. No. 34162 B.

Transformers.

Inductive E. M. F. in Transformers. John B. Whitehead, Jr. Deals with the graphic representation of the drop of pressure, and with the algebraic estimation of the inductive drop as dependent upon the relative association of the primary and secondary coils. 2000 w. Elec Wld & Engr—May 5, 1900. No. 34026.

LIGHTING.

Arc Lamp.

Arc Lamp with Inclined Carbons Bagenlamp mit Schräg gegen Einander Gestellten Kohlen). An illustrated description of a lamp in which the carbons are inclined to each other at a small angle with the horizontal and are kept at the proper distance apart by a non-conducting block. 500 w. Elektrizität—April 28, 1900. No. 34176 C.

A Comparison of Open and Enclosed Arc Lamps for Street Lighting. H. H. Wait. A review of some of the principal points. 2500 w. Am Elect'n—June, 1900. No. 34456.

Incandescence.

The Weak Spot in Incandescent Electric Lighting from Central Stations. Francis W. Willcox. A discussion of the lamp question, advocating free supply and regular renewal. 2200 w. Am Elect'n—May, 1900. No. 33939.

Johannesburg.

Electric Lighting in Johannesburg. J. R. Cowell. Read at meeting of the South African Assn.of Engs. A few questions of local interest are discussed and regularity of supply, cost, etc., considered. 2000 w. Archt, Lond—April 20, 1900. No. 33908 A.

Malta.

The Electric Light Plant of Malta. R. W. Ashcroft. Illustrated description. 900 w. Elec Wld & Engr—May 26, 1900. No. 34422.

Photometry.

See under Measurements, below.

Street Lighting.

Arrangement of Incandescent Street Lamps. Alton D. Adams. A discussion of this subject, showing the incandescent lamps are satisfactory and economical when the right methods are used. 1400 w. Elec Rev, N. Y.—May 16, 1900. No. 34345.

MEASUREMENT.

Alternating Currents.

Tracing Alternating Current Curves by Instantaneous Contact Methods (Die Punktweise Aufnahme von Wechselstromkurven). Dr. F. Niethammer. Criticising different methods and expressing preference for that of Joubert, with condenser and ballistic galvanometer; with diagrams. 400 w. Elektrotech Zeitschr—April 19, 1900. No. 34110 B.

Computator.

A Mechanical Computator for Alternating Current Circuits. William Hand Browne, Jr. Explains the principle and construction of an instrument for solving mechanically any wiring problem for direct currents and its application to alternating currents. 1000 w. Tech, No. 14—1899-1900. No. 34384 D.

Magnetic Tests.

Magnetic Tests of Sheet Iron (Die Magnetische Prüfung von Eisenblech). I. Epstein. An account of tests by practical and accurate methods, with tables, diagrams and illustrations. 2500 w. Elektrotech Zeitschr—April 19, 1900. No. 34108 B.

Oscillograph.

The Duddell Oscillograph. An illustrated detailed description of an electrical measuring apparatus. 1300 w. Engng—May 4, 1900. No. 34247 A.

Photometry.

Photometry for Central Stations. Lyman C. Reed. Part first describes various photometers. 1500 w. Am Elect'n—May, 1900. Serial. 1st part. No. 33940.

POWER APPLICATIONS.

Electric Driving.

Systems and Efficiency of Electric Transmission in Factories and Mills. William S. Aldrich. Considers the conditions where electric driving is an advantage and the fields it best serves, its efficiency, systems of distribution, and economies effected. 4200 w. Trans Am Soc of Mech Engs. No. 858—May, 1900. No. 34098 C.

The Development of the Electric Drive for Cotton Mills. Extracts from a paper by Sidney B. Paine, read before the Southern Cotton Spinners' Assn., giving facts of general interest to engineers. 1100 w. Eng News—May 17, 1900. No. 34314.

Elevators.

Automatic Reversing and Starting Resistances for Electric Elevators (Selbstthätige Umkehr-Anlasswiderstände für Elektrische Aufzüge). An illustrated description of apparatus used in connection with motors for operating electric elevators. 700 w. Elektrizität—April 28, 1900. No. 34174 C.

Mining Uses.

See Mining and Metallurgy, Mining.

Portable Motors.

Portable Electric Motors. Protected Against Dust and Dirt (Fahrbare, gegen Staub und Schmutz geschützte Elektromotoren). Ernst Schulz. A short illustrated description of a portable motor. 500 w. Glückauf—May 12, 1900. No. 34154 B.

Railway Work.

Electricity as a Motive Power on Railways (Die Elektricität als Zugkraft auf Eisenbahnen). H. Frahm. An illustrated account of the application of electric power for heavy railway work, with descriptions of some electric locomotives. Two articles. 8500 w. Stahl und Eisen—April 15, May 1, 1900. No. 34128 each D.

Speed Regulation.

Regulation of Variable Speed Motors by Varying Impressed and Counter E. M. F's. L. B. Mather. Illustrates and describes several systems that may be used advantageously. 1200 w. Am Elect'n—May, 1900. No. 33936.

Rheostat, Double Commutator and Multi-Voltage Control. Alton D. Adams. Illustrates and describes various means of special regulation and the work to which they are suited. 4500 w. Am Elect'n—May, 1900. No. 33935.

Speed Control of Motors Driving Printing Presses and Machine Tools. Illustrates and describes satisfactory methods. 1000 w. Am Elect'n—May, 1900. No. 33937.

Starting Resistances.

The Graduation of Starting Resistances for Direct-Current Motors (Die Stufung von Anlassern für Gleichstrommotoren). Rudolf Krause. Directions for the proper design of starting resistances, with diagrams and formulæ. 600 w. Elektrotech Zeitschr—April 26, 1900. No. 34113 B.

Works.

Electric Distribution of Power as Applied to Works and Factories. George Harland Bowden. Read before the Glasgow Univ. Engng. Soc. Discusses the economy and increased efficiency, giving results obtained in important works. 3200 w. Elec Eng, Lond—April 27, 1900. Serial. 1st part. No. 34057 A.

TRANSMISSION.

Long Distance.

On Distant Electric Power Transmission. George Forbes. Read before the Inst. of Elec. Engs. Describes selected plants, and their points of interest, and the problems of attaining the highest economy. Discussion. 6700 w. Elec Eng, Lond—May 4, 1900. Serial. 1st part. No. 34269 A.

Wire Tension.

Tables for Designing Aerial Electric Wires in Tension (Abaques Pour le Montage des Lignes Electriques Aériennes). Ed Liégeois. Tables, formulæ and explanation. 1000 w. Génie Civil—May 12, 1900. No. 34188 D.

MISCELLANY.

Address.

The Relations between Electricity and Engineering. William Henry Preece. The "James Forrest" Lecture, delivered before the Inst. of Civ. Engs. Considers the uses to which electricity has been, and may be put to achieve engineering results. 6500 w. Elec Eng, Lond—April 27, 1900. No. 34056 A.

Agriculture.

Application of Electrical Energy to Agriculture (L'Application de l'Energie Electrique à l'Agriculture). Paul Renaud. An illustrated general article on various applications of electric motors to farm work. Serial. 1st part. 1600 w. Electricien—April 28, 1900. No. 34197 B.

Applied Electricity.

Applications of Electrical Science. G. F. Fitzgerald. Abstract of address to the Dublin Section of the Inst. of Elec. Engs. Brief review of the history of applied electricity, its progress, etc. 2300 w. Nature —May 10, 1900. No. 34364 A.

Carbon.

The Properties of Carbon in Electrical Work. Elihu Thomson. The first part of an interesting paper showing the importance and use of carbon in the electrical arts. 2500 w. Elec Wld & Engr—May 12, 1900. Serial. 1st part. No. 34288.

Electrical Equipment.

The Electrical Equipment of the Electrical Engineers' (R. E.), Volunteer Corps. Illustrates and describes the novel equipment sent to South Africa, consisting of traction engines, search lights, limbers, cable drum carriages, and telephones. 2700 w. Elect'n, Lond—April 27, 1900. No. 34053 A.

Electrical Equipment of a Mammoth Packing House. J. E. Smith. Illustrated description of the motive power and refrigerating plant of the Armour establishment. 3700 w. Am Elect'n—May, 1900. No. 33934.

Italy.

Recent Italian Electrical Developments. Giovanni Georgi. An account of electrical enterprises of recent date. 900 w. Elec Wld & Engr—May 5, 1900. No. 34028.

Lightning.

The Protection of Public Buildings from Lightning. Killingworth Hedges. Discusses methods of protection used, and gives suggestions. General discussion. Ill. 11000 w. Jour Roy Inst of Brit Archts—April 28, 1900. No. 34397 B.

Lightning Rods.

Lightning Rods (Ueber Gebäude-Blitzableiter). K. Streeker. Report of a committee of the *Elektrotechnischer Verein,* reviewing the subject, and proposing certain regulations and specifications. 2500 w. Elektrotech Zeitschr—April 26, 1900. No. 34115 B.

Paris Exposition.

Editorial Review of the German Electrical Exhibit at the Paris Exposition, with Plan. 700 w. Elektrotech Zeitschr —May 3, 1900. No. 34116 B.

Electricity at the Paris Exposition of 1900. An illustrated description of the nature and features of this Exposition, especially the electrical exhibits. 9300 w. Elec Wld & Engr—May 5, 1900. No. 34025.

Some Electrical Art Features at the Exposition. Illustrates and describes some electrical decorative features of interest. 1500 w. Elec Wld & Engr—May 26, 1900. No. 34423.

The Electricity Palace at the Paris Exposition (Exposition de 1900. Le Palais de l'Electricité). J. A. Montpellier. A general description of the electrical building and the "Water Chateau," with a plan. 1100 w. Electricien—April 21, 1900. No. 34195 B.

GAS ENGINEERING

Acetylene.

The Present State of the Acetylene and Carbide Industry (Ueber den Heutigen Stand der Acetylen- und Carbid- Industrie). Victor Berdenich. Paper before the *Oesterr Ingenieur-und Architekten-Verein,* giving an account of the present state of the art in Europe. 5500 w. Zeitschr d Oest Ing u Arch Ver—April 13, 1900. No. 34135 B.

Some Enemies of Acetylene. Discusses ill-designed generators, and other things which have been of harm to this industry. 2500 w. Engr, Lond—April 27, 1900. No. 34070 A.

Address.

President's Address before the Institution of Gas Engineers. J. W. Helps. Considers coal gas and carburetted water gas under present conditions, and discusses the naphthalene difficulty. 7000 w. Gas Wld —May 5, 1900. No. 34249 A.

Benches.

Regenerative Benches. Howard C. Slater. Read at meeting of the Western Gas Assn. Considers their advantages and management. Also general discussion. 5000 w. Am Gas Lgt Jour—May 28, 1900. No. 34442.

Berlin.

The Municipal Gas Works of Berlin (Die Städt. Gaswerke Berlins). Abstract of the report for 1898-99, with tables and general figures. 700 w. Gesundh Ingenieur—May 15, 1900. No. 34161 B.

Calorific Power.

The Calorific Power of Illuminating Gas. Harold G. Colman. Read before the Inst. of Gas Engs. Illustrates and describes Junker's calorimeter, and the manner of making tests. General discussion. 7000 w. Gas Wld—May 5, 1900. No. 34251 A.

Coal Tar.

The Manufacture of Coal Tar Derivatives (Fabrication des Dérivés du Goudron de Houille). A long illustrated article on a variety of coal tar products. Serial. 1st part. 3000 w. Revue Technique—April 25, 1900. No. 34479 D.

Econometer.

Test of Arndt's Gas Weighing Econometer. C. R. Jones and Austin Burt. Describes the apparatus and method of operation and underlying principles, the tests and results. 3000 w. Sib Jour of Engng—May, 1900. No. 34488 C.

Enrichment.

The Carbonization of Cannel and Shales for Gasmaking Purposes. Samuel Glover. Read before the Inst. of Gas Engs. How to make the best use of enrichment material when it is subjected to distillation or decomposition of heat. 6200 w. Gas Wld—May 5, 1900. No. 34255 A.

The Enrichment of Coal Gas. George Livesey. Read before the Inst. of Gas Engs. Considers whether enrichment is advisable. General discussion. 6000 w. Gas Wld—May 5, 1900. No. 34250 A.

Foundations.

Effective and Defective Foundations for Gas Machinery. George D. Rice. Illustrates and notes defects in systems employed, weak floor foundations and the results in gears. 1200 w. Am Gas Lgt Jour —April 30, 1900. No. 33958.

Gas Coal.

Gas Coal: Its Present Price and Effect Upon the Gas Industry. Discussion, opened by R. G. Shadbolt, before the Eastern Counties Gas Mgrs. Assn. 3300 w. Gas Wld—April 21, 1900. No. 33910 A.

Mantles.

The Incandescent Gas Mantle and Its Use. Vivian B. Lewes. Cantor Lecture. An interesting paper reviewing the history of incandescent lighting and the development of Dr. Auer von Welsbach's discovery. giving also suggestions. 5000 w. Gas Wld—May 12, 1900. No. 34366 A.

Meters.

Gas and Gas Meters. Herbert S. Wynkoop. Discusses the causes of poor gas, and the accuracy of gas meters. Ill. 3000 w. Pop Sci M—June 1900. No. 34426 C.

Naphthalene.

The Presence of Naphthalene in Coal Gas. Wilfred Irwin. Read before the Inst. of Gas Engs. Its detection and extraction are discussed, and a table is given showing the condensable constituents of gas produced by a ton of Lancashire coal carbonized at a high temperature, with comments. Lengthy discussion. 8000 w. Gas Wld—May 5, 1900. No. 34254 A.

Retorts.

Inclined Retorts at Bankside. Charles C. Carpenter. Read before the Inst. of Gas Engs. In substituting inclined for horizontal retorts they were designed to fit the existing building. The reasons for adopting the various details are explained. Ill. General discussion. 7500 w. Gas Wld—May 5, 1900. No. 34252 A.

Street Lighting.

Street Lighting by Incandescent Gas Burners. J. H. Sheldrake. Read before the Eastern Counties' Gas Mgrs. Assn. Practical hints to assist those inexperienced, with general information and discussion. 7000 w. Gas Wld—April 21, 1900. No. 33909 A.

Tanks.

Some Examples of Tank Construction. F. W. Stevenson. Read before the Inst. of Gas Engs. Relates experiences in the construction of gasholders and similar tanks. Ill. 2800 w. Gas Wld—May 5, 1900. No. 34256 A.

Water Gas.

Medical Men and Carburetted Water Gas. J. S. Haldane. Extracts from a paper read before the Inc. Soc. of Med. Officers of Health, on the risks attending the use of carburetted water gas for domestic lighting purposes. 3400 w. Gas Wld—April 28, 1900. No. 34051 A.

The Manufacture and Application of Water Gas. Carl Dellwik. Read before the Iron and Steel Inst. An explanation of the theory on which the Dellwik-Fleischer process is based and the results obtained in practice, giving also applications made for manufacturing purposes. Ill. 5000 w. Col Guard—May 11, 1900. No. 34371 A.

Water Gas and Its Recent Continental Developments. Vivian B. Lewes. Read before Inst. of Gas Engs. Reviews the history of water gas, and describes in detail the Dellwik-Fleischer process. 10000 w. Gas Wld—May 5, 1900. No. 34253 A.

MARINE AND NAVAL ENGINEERING

American Marine.

The Upbuilding of the American Merchant Marine. Illustrated description of freight and passenger steamers under construction in the Delaware and the Clyde. 1000 w. Sci Am—May 5, 1900. No. 33968.

Barges.

Schooner Rigged Steel Tow Barges for Deep Water Trade. Illustrates and describes vessels designed especially for this service. 1000 w. Marine Engng—May, 1900. No. 34047 C.

Cable Ship.

The Cable-Laying Ship "Von Podbielski" (Le "Von Podbielski" Navire Poseur de Câbles). A brief general description of this German cable ship, built at Port Glasgow, with illustrations. 800 w. Génie Civil—April 28, 1900. No. 34182 D.

Coaling.

An Apparatus for Coaling at Sea. T. Spencer Miller. Lecture before the Worcester Co. Mech. Assn. An illustrated description of the cableway for coaling at sea, invented by the author. 6000 w. Jour of Worcester Poly Inst—May, 1900. No. 34087 C.

Crank Shafts.

See Mechanical Engineering, Machine Works and Foundries.

Cruiser.

The Imperial Japanese Cruiser "Yakumo." Illustrated descriptive comparison with the "Asama." 350 w. Engr, Lond—May 4, 1900. No. 34258 A.

Destroyer.

H. M. Torpedo-Boat Destroyer "Viper." Leading particulars of the vessel and account of the official trial. 1400 w. Engng—May 11, 1900. No. 34358 A.

Docks.

See Civil Engineering, Hydraulic and Marine.

Engines.

See Marine Engines, under Mechanical Engineering, Steam.

Fire Boat.

Detroit Fire Boat. Illustrated description of a modern vessel of the fire-fighting kind. The pumps have a capacity of 6000 gallons per minute. 600 w. Marine Rev—May 17, 1900. No. 34320.

Floating Dry Dock.

The 15,000-Ton Floating Dry-Dock for the U. S. Naval Station at Algiers, La. Illustrated detailed description, with the reasons which influenced its construction. 2000 w. Eng News—May 3, 1900. No. 33979.

Germany.

German Shipbuilding and Its Allied Industries (Der Deutsche Schiffbau und seine Hülfsindustrien). Prof. Oswald Flamm. A general account of the progress of German shipbuilding, with good illustrations showing the effects of collisions. 2800 w. Stahl und Eisen—May 1, 1900. No. 34130 D.

The Progress of the German Mercantile Marine. Considers the present position and the objects in view, as revealed in the yearly reports of the shipping companies. 2800 w. Engr, Lond—May 11, 1900. No. 34367 A.

Harbor Defence.

Coast and Harbor Defence, with Some Notes on the Spanish War. Caryl D. Haskins. Discusses the problem of defending a coast city under present conditions. 4500 w. Jour of Worcester Poly Inst—May, 1900. No. 34086 C.

Marine Engines.

Engines and Boilers of the "Deutschland." Illustrated description. 400 w. Sci Am Sup—May 26, 1900. No. 34406.

The Naval Steam Engine—Its Graphics and Economics Illustrated. Robert H. Thurston. A study relating to the machinery of the U. S. S. "Maine," and of general efficiency. 2500 w. Marine Engng—May, 1900. No. 34042 C.

Triple Expansion Engines of the Dutch Armoured Cruiser "Noord Brabant" (Machines à Triple Expansion du Croiseur Cuirassé Hollandais le "Noord Brabant"). M. Hachelet. A fully illustrated description of these 10,000 H. P. engines, with general remarks on the Yarrow boilers and the cruiser herself. 1 plate. 3500 w. Génie Civil—May 12, 1900. No. 34186 D.

Modern Navies.

Modern Navies (Les Marines de Guerre Modernes). M. de Chasseloup-Loubat. A full general treatment of the subject. Serial. 1st part. 5600 w. Bull de la Soc d'Encour—March 31 1900. No. 34178 G.

Propeller Shafts.

Corrosion and Failure of Propeller Shafts. A. Scott Younger. Read before the Inst. of Naval Archts. An endeavor to account for the extreme corrosion which is found to occur at the ends of the brass liners on tail-end shafts, with a review of some of the methods that have been suggested to overcome this difficulty. Ill. 3500 w. Engr. Lond—April 20, 1900. No. 33920 A.

Resistance.

On the Influence of Depth of Water on the Resistance of Ships. Giuseppe Rota. Read before the Inst. of Naval Archts. An account of experimental tests carried out in the tank of the Royal Dockyard of Spezia, Italy, giving curves of resistance. 1400 w. Engng—April 20, 1900. No. 33-943 A.

Shell Fire.

The Bellisle Experiments. Describes experiments to be made on this battleship to test the effect of modern shell fire on personnel and material. Ill. 1000 w. Engng—May 18, 1900. No. 34469 A.

Shipyard Appliances.

Overhead Cranes, Staging and Riveter-Carrying Appliances in the Shipyard. James Dickie. Illustrated detailed description of the wooden framework in the shipyard of the Union Iron Works in San Francisco. 1500 w. Marine Engng—May, 1900. No. 34044 C.

Speed Record.

An Account of a Record-Breaking Trip Across the Pacific Ocean. William H. Crawford, Jr. An account of fine record made by the steamship "Empress of Japan" in 1897. 1000 w. Marine Engng —May, 1900. No. 34048 C.

Steamboat.

Particulars of the Long Island Sound Steamboat, "Chester W. Chapin." Illustrations, plans and description. 450 w. Marine Engng—May, 1900. No. 34041 C.

Steamer.

New Coastwise Steamers. Illustrated description of the "Chesapeake," just completed for the New York and Baltimore outside line. 1000 w. Naut Gaz—May 17, 1900. No. 34318.

Steamships.

New 18,000 Ton Vessels for the Pacific Mail Steamship Co. Illustrated description of fine steamers being built at the Newport News yard. 1300 w. Marine Engng—May, 1900. No. 34046 C.

New Steamship "Comus." Illustration and description of the Cromwell liner that went into commission this month, running between New York and New Orleans. 1800 w. Naut Gaz—May 24, 1900. No. 34418.

New Type Steamship. Illustrated description of the "Tampico," built at Toledo, Ohio, and designed for ocean as well as lake service. 1500 w. Naut Gaz—May 10, 1900. No. 34218.

Submarine.

The Demonstrated Success of the Submarine Boat. Admiral Philip Hichborn. A review of the history of submarine navigation, of the present state of the art, and of the mechanical and tactical efficiency of the newest craft and their effect on naval construction policy and naval strategy. 5000 w. The Engineering Magazine—June, 1900. No. 34497 B.

Submarine Boats. Editorial comment on the steps taken by France and the United States toward providing for the construction of these boats. Also gives a historical review of experiments made in this field. 2000 w. Engng—April 27, 1900. No. 34060 A.

The Question of Submarine Boats. Edmund Robertson. Discusses England's attitude toward the vessels of this type, questioning its wisdom. 5000 w. Nineteenth Cent—May, 1900. No. 34328 D.

Torpedoes.

Steering Torpedoes by Means of Wireless Telegraphy. F. A. A. Talbot. An account of experiments made by Mr. Varicas, the inventor of the system, with successful results. 900 w. Sci Am—May 12, 1900. No. 34210.

Traffic.

Sea Borne Traffic. James Adamson. Abstract of paper read before the Inst. of Marine Engs. Notes the great improvements in water transportation, the advantages, cost, etc. 1800 w. Ir & Coal Trds Rev—May 4, 1900. No. 34263 A.

Wages.

Wages Paid Mechanics in the Private Shipyards of Foreign Nations. Information of importance from a standpoint of competition in vessel construction. 2200 w. Marine Engng—May, 1900. No. 34-045 C.

Warships.

The Electrical Equipment of Ships of War. C. E. Grove. Read before the Inst. of Elec. Engs., England. A discussion of what has been accomplished, and the tendency of the developments. Part first considers dynamos and switchboards. Ill. 1800 w. Elect'n, Lond—April 20, 1900. Serial. 1st part. No. 33911 A.

The Electrical Equipment of Ships of War. Editorial review of the discussion before the Inst. of Elec. Engs. and showing that many appliances are useless in time of battle, and that radical change in the equipment of ships of war is not now advisable. 2500 w. Engng—May 11, 1900. No. 34357 A.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

Competitive Tests of Accumulators (Preisausschreiben auf Akkumulatoren). C. Reimer. An account of the competitive tests made by the Automobile Club of France, from June 3 to Dec. 2, 1899, with a table showing results. 1500 w. Elektrochem Zeitschr—May, 1900. No. 34-171 G.

The Treatment of Accumulators for Working Spark Coils. Discusses the management and treatment of the accumulator as a source of current for the various electric sparking appliances that are employed for the ignition of the explosive mixtures in certain classes of oil engines adapted for the propulsion of motor cars. 2000 w. Auto Jour—May 17, 1900. No. 34483 A.

Bollée Vehicle.

The Bollée Voiturette. Illustrated detailed description of a vehicle built on the lines of the tricycle. 2200 w. Sci Am Sup—May 5, 1900. No. 33970.

Combination Systems.

Combination Systems. P. M. Heldt. Description, with two illustrations, of these systems, with remarks on their advantages and disadvantages. 1700 w. Horseless Age—May 9, 1900. No. 34219.

Competition.

The Automobile Club's 1000-Mile Trial. Gives the itinerary and the important features of the vehicles entered. 2500 w. Engr, Lond—April 27, 1900. No. 34073 A.

Gasoline Carriage.

The Georges Richard Voiture. Illustrated description of the latest type. Condensed from *La France Automobile.* 1200 w. Horseless Age—May 16, 1900. No. 34322.

The Packard Gasoline Carriage. Illustrated description. 800 w. Horseless Age—May 16, 1900. No. 34321.

Heavy Duty.

Motor Vehicles for Heavy Traffic. A report of the trials of the Liverpool Self-Propelled Traffic Assn., with illustrations of two of the vehicles. 1600 w. Sci Am Sup—May 12, 1900. No. 34212.

The Automobile Wagon for Heavy Duty. Arthur Herschmann. States the conditions which make these vehicles most desirable, considering the construction, propulsion, etc. Ill. 6500 w. Trans Am Soc of Mech Engs, No. 853—May, 1900. No. 34094 C.

Liquid Fuel Motors.

Liquid Fuel Motors for Vehicles (Fahrzeugmotoren für Flüssige Brennstoffe). Hugo Güldner. A fully illustrated account of many types of liquid fuel motors. Serial. 1st part. 3600 w. Zeitschr d Ver Deutschr Ing—April 28, 1900. No. 34104 D.

Lubrication.

The Lubrication of Motor Vehicles and Cycles. Information from a pamphlet written by J. Veitch Wilson. 1400 w. Auto Jour—May 17, 1900. No. 34481 A.

Mechanical Propulsion.

Road Locomotion. H. S. Hele-Shaw, with appendices by experts. Discusses the general principles of the engineering features of the question; the behavior of the wheel upon the road, steering and turning, motive power and transmission, etc. Ill. 17500 w. Inst of Mech Engs—1900. No. 34088 D.

Military Uses.

War and Power Traction. J. H. A. Macdonald. Read before the Automobile Club. On the great service that could be rendered by successful construction of transport vehicles. 5500 w. Auto Jour—May 17, 1900. No. 34485 A.

Pneumatic Tires.

The Manufacture of a Pneumatic Tire. From *La Nature.* Illustrated detailed description with related information. 2500 w. Sci Am Sup—May 12, 1900. No. 34211.

Steam Carriage.

The Stanley Steam Carriage. Illustrated description. 800 w. Auto Jour—May 17, 1900. No. 34482 A.

Steering.

The Pivot Steering Gear in Practice. P. M. Heldt. Illustrated description. 800 w. Horseless Age—May 2, 1900. No. 33985.

Storage Batteries.

The Selection of a Storage Battery for an Automobile. George T. Hanchett. Gives a method for determining the speed and radius of the vehicle, illustrating by working out the problem for a given vehicle. 500 w. Am Elect'n—June, 1900. No. 34459.

Testing.

Formulæ for Designing and Testing Automobiles (Formelu zur Berechnung und Prüfung von Automobilen). Dr. Walter Kummer. Theoretical discussion of the determination of the efficiency of self-propelling vehicles. 1000 w. Elektrotech Zeitschr—May 3, 1900. No. 34118 B.

Trials.

The Automobile Club's 1000-Mile Trial. A general account of the vehicles completing the run and of their performance. 2000 w. Engr, Lond—May 18, 1900. No. 34468 A.

The 1000-Mile Trial of the Automobile Club of Great Britain and Ireland. An account of the vehicles, hill climbing records, and speed trials. 7000 w. Auto Jour—May 17, 1900. No. 34484 A.

HYDRAULICS.

Water Power.

Industrial Works at Terni, Italy (Terni Industriel). An article from the *Rivista di Artiglieria e Genio,* giving a general description of various applications of the hydraulic power of the Néra and Vélino rivers, near Terni, Umbria. 5000 w. Revue Technique—April 10, 1900. No. 34477 D.

Water-Wheels.

The Tangential Water-Wheel. W. A. Doble. Reviews the development of open or impulse water-wheel and the results, discussing briefly its adaptability in the engineering field. Ill. 12600 w. Trans Am Inst of Min Engs—Sept., 1899. No. 34040 D.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Burned Iron. Edward Kirk. Its deceptive fracture is discussed, and how it should be judged. Also remarks on scrap. 1200 w. Foundry—May, 1900. No. 33971.

Malleable Cast Iron.

Annealing Malleable Cast Iron. George C. Davis. Read at meeting of the Foundrymen's Assn. Experiments and results are presented, and the paper is discussed by Richard Moldenke. 2500 w. Foundry—May, 1900. No. 33972.

Steam Metal.

Steam Metal. Erwin S. Sperry, in *The Aluminum World.* The name is applied to a copper alloy used in the manufacture of steam goods. Gives results of experiments, considering its composition, strength, etc. 1300 w. Foundry—May, 1900. No. 33973.

Steel Specifications.

See Mining and Metallurgy, Iron and Steel.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

Boiler Formers at the Richmond Locomotive and Machine Works. Engravings and table showing method of filing and keeping records of certain locomotive boiler parts. A system devised by Millard F. Cox. 400 w. R R Gaz—May 18, 1900. No. 34350.

Boring Tool.

A Geometric Boring Tool. Illustrated description of a recent device for boring other than round holes. 1700 w. Am Mach—May 3, 1900. No. 33961.

Castings.

Fillets and Round Corners on Castings. John M. Richardson. Read at Pittsburg meeting of the Am. Foundrymen's Assn. Discusses the merits and demerits of fillets, and means of securing good castings. 2500 w. Sci Am Sup—May 5, 1900. No. 33969.

Crane.

The Carl Flohr 25-Ton Electric Travelling Crane at the Paris Exposition (Pont Roulant Electrique de 25 Tonnes de l'Usine Suffren). A well illustrated description of this fine crane in the German section of Machinery Hall. 1 plate. 1500 w. Génie Civil—April 28, 1900. No. 34181 D.

Crank Shafts.

Crank Shafts. John Brady. Considers the construction of stationary and marine crank shafts, the materials used, and their bearings on present-day practice. Ill. 2500 w. Engr, Lond—May 4, 1900. No. 34260 A.

Cupola Practice.

Carbide of Silicon in Cupola Practice—A New Softener. F. J. Tone. The value of this product to the founder, its action, method of handling, etc. 1000 w. Foundry—May, 1900. No. 33974.

Cylinder.

Machining a Steam Cylinder. Illustrated description of the work. 1600 w. Am Mach—May 24, 1900. No. 34399.

Education.

Education of Machinists, Foremen, and Mechanical Engineers. M. P. Higgins. A discussion of the requirements, and questions of interest. 8500 w. Trans Am Soc of Mech Engs, No. 864—May, 1900. No. 34203 C.

Flywheels.

An Outfit for the Manufacture of Large Segmental Flywheels. Illustrations and brief notes relating to the special outfit used by the E. P. Allis Co. 500 w. Am Mach—May 10, 1900. No. 34217.

Gear Cutting.

The Rice Bevel Gear Cutting Machine. An illustrated detailed description of a bevel-gear cutting machine based upon an entirely new principle. 2800 w. Am Mach—May 10, 1900. No. 34216.

Lathes.

Conveniences for a Pattern Maker's Lathe. Illustrates and describes satisfactory attachments used for a number of years. 1000 w. Am Mach—May 24, 1900. No. 34401.

Movement.

A New Mechanical Movement. C. R. Gabriel. Illustrated description of a new movement especially useful in mechanism in which a rotary gear is to be driven for a part of a revolution at a constant speed, and started and stopped without jar. 1200 w. Am Mach—May 17, 1900. No. 34305.

Paris Exposition.

The Paris Exposition of 1900 (Die Weltausstellung in Paris, 1900). A very well illustrated account of some of the principal German exhibits in Machinery Hall, including the Carl Flohr traveling crane, a Borsig engine, a Siemens-Halske dynamo and machine tools. 8000 w. 3 plates. Zeitschr d Ver Deutscher Ing—April 14, 1900. No. 34102 D.

Piece Work.

New Shop Methods a Corollary of Modern Machinery. An editorial showing that labor's opposition to the new wage system is like their former opposition to machinery, and equally futile. Improved machinery and intensified production are parts of the same movement. 1800 w. The Engineering Magazine—June, 1900. No. 34491 B.

Piece Work Not Essential to Best Results in the Machine Shop. James O'Connell. An official statement of the attitude of American organized labor.

3600 w. The Engineering Magazine—June, 1900. No. 34495 B.

Premium Plan.

The Economics of the Premium Plan. F. A. Halsey. Abstract of a lecture before the Providence Soc. of Mech. Engs. An explanation of the system, giving figures and statements from representative concerns in support of arguments in its favor. 3200 w. Am Mach—May 3, 1900. No. 33963.

Screw Threads.

The S. J. Standard Metric Thread in Continental Europe. Henry Hess. Reviews the efforts to secure uniformity in screw threads, and the shape adopted in Continental Europe, giving considerations to be weighed by the American manufacturer who desires to sell in foreign markets. Ill. 1200 w. Am Mach—May 3, 1900. No. 33965.

Shafts.

On Mysterious Fractures of Steel Shafts. R. Schanzer. Read before the Inst. of Nav. Archts. Describes a particular brittle structure observed in a suddenly fractured shaft that was presented for examination. Ill. 4700 w. Engng—April 27, 1900. No. 34062 A.

Shops.

Enlarged Plant of the Bullard Machine Tool Co.—Striking Examples of Jig Work. Illustrated description of interesting features in this shop at Bridgeport, Conn., its fittings, methods, etc. 2800 w. Mach, N. Y.—May, 1900. No. 33929.

Messrs. Ferranti's Hollinwood Works. Illustrates and describes some of the principal products of these works. 3300 w. Elec Eng, Lond—May 18, 1900. Serial. 1st part. No. 34476 A.

Shops of Wells Brothers, Greenfield, Mass. Interesting views and brief description of an establishment for the manufacture of taps and dies and screw-cutting appliances. 500 w. Am Mach—May 3, 1900. No. 33962.

The Works of Sir William Arrol & Co., Limited. Illustrated detailed description of one of the most notable bridge-building establishments of Glasgow. 2200 w. Engr, Lond—May 18, 1900. Serial. 1st part. No. 34467 A.

Speed Cones.

On the Design of Speed Cones: A New Formula. James J. Guest. Explanation of method. 700 w. Trans Am Soc of Mech Engs, No. 861—May, 1900. No. 34200 C.

Tools.

Designing Jigs and Fixtures. Edwin C. Thurston. Helpful suggestions for shop work. 1900 w. Mach, N. Y.—May, 1900. No. 33930.

Turret Head.

Origin of the Turret, or Revolving Head. E. G. Parkhurst. Historical review of inventions belonging to this class, illustrating and describing some of them. 2200 w. Am Mach—May 24, 1900. No. 34398.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Systems for the classification of shop orders, working plans for securing speed, accuracy and economy in the progress of work through the shop. 2700 w. The Engineering Magazine—June, 1900. No. 34496 B.

Workshop Administration. David Cowan. Considers the administration a branch of the productive art, and makes special reference to tracing work and ascertaining detailed costs and profits. 6400 w. Trans Inst of Engs & Shipbuilders in Scotland—April, 1900. No. 34327 D.

POWER AND TRANSMISSION.

Blast-Furnace Gas.

On the Production and Use of Power from Blast-Furnace Gas. Horace Allen. Read before the So. Staffordshire Ir. and Steel Inst. States the conditions affecting the combustion, the difficulties attending the economical application of blast-furnace gas for raising steam, reviewing the objections made to gas engines in iron works, etc. 2500 w. Ir & Coal Trds Rev—April 27, 1900. No. 34059 A.

See also Blowing Engine, under Special Motors, below.

Cableway.

The Log Cableway at Richtersweiler, Switzerland (Die Richtersweiler Holzriese). Prof. W. Ritter. An illustrated description of an aerial wire cableway 2,100 yards long, for transporting logs weighing 2 tons. Serial. 1st part. 1800 w. Schweiz Bauzeitung—May 12, 1900. No. 34165 B.

Flywheel Accidents.

Flywheel Accidents. Read by Prof. Sharp before the Civ. and Mech. Engs.' Soc. Considers the causes of bursting, and gives illustrated description of various designs, including one by the writer. 2200 w. Ir & Coal Trds Rev—May 4, 1900. No. 34262 A.

Furnace Charging.

Furnace Charging Apparatus. Illustrates and describes an invention to be adopted by the National Tube Works to carry skelp or plates to be heated. 2200 w. Am Mfr & Ir Wld—May 3, 1900. No. 33988.

Mechanical Transport.

Temperley Transporting Plant at Sfax.

Illustrates and describes an interesting plant recently constructed for handling phosphates. 1400 w. Engng—May 11, 1900. Serial. 1st part. No. 34356 A.

Office Building.

Power Equipment of the Tall Office Building. R. P. Bolton. A discussion of the economies of a new class of small central stations, in the light of the latest storage battery practice, and of the demands of lighting and elevator service. 3500 w. The Engineering Magazine—June, 1900. No. 34494 B.

Power Development.

The Big Blast and Power Development of the Pike's Peak Power Co. Illustrated description of a large blast to secure granite to build a dam, with account of the work. 900 w. Eng News—May 17, 1900. No. 34308.

Pneumatic Dispatch.

London's Lost Tunnel. An illustrated account of this tunnel, constructed to carry the mails and postal parcels between the two terminal points by means of pneumatic pressure. 2500 w. Compressed Air—May, 1900. No. 34292.

Transmission.

Power Transmission by Gas and Electricity. Alton D. Adams. Discusses the efficiencies of steam and gas engines for generating electric power; the relative losses and expenses in transmitting power for long distances by electric wires and by gas in pipes, and the commercial limits to the practicability of each. 3200 w. Mines & Min—May, 1900. No. 34010 C.

Vibromotor.

The Vibromotor Automatically Balanced Screening Machinery. Illustrates and describes an apparatus for utilizing the vibrations set up in a reciprocating or gyratory piece of machinery. 800 w. Col Guard—May 11, 1900. No. 34372 A.

SPECIAL MOTORS.

Blowing Engine.

Communication on the Test of the First Blast-Furnace Gas Blowing-Engine (Mittheilungen über die Versuche mit der Ersten Hochofengas-Gebläsemaschine). Preliminary account of a successful test of the large Delamare-Cockerill blowing-engine at Seraing, Belgium. 500 w. Stahl und Eisen—April 15, 1900. No. 34125 D.

On a Blowing Engine Worked by Blast Furnace Gas. Adolphe Greiner. Read before the Iron and Steel Inst. Abstract of the results obtained at the Cockerill Works with the first blowing engine worked by blast-furnace gas ever employed in any iron works. 1200 w. Engng—May 11, 1900. No. 34359 A.

Engine Tests.

Tests of a 10 H. P. Otto Gasoline Engine. H. A. Soverhill. Tests made to determine the gasoline consumption per brake and indicated horse-power per hour, the mechanical efficiency of the engine, and also a heat balance. Ill. 1000 w. Tech, No. 14—1899-1900. No. 34390 D.

Gas Engines.

The Use of Blast Furnace Gases in Gas Engines at Works in Silesia (Verwendung der Hochofengase zum Betriebe von Gasmaschinen auf der Dormersmarckhütte und Friedenshütte). Papers read before the *Eisenhütte Oberschlesien*, giving the results of practical operation. 3000 w. Stahl und Eisen—April 15, 1900. No. 34124 D.

Gas Turbine.

An Investigation of the Gas Turbine. W. O. Amsler. Mathematical and experimental investigation of the actions going on in the explosion chamber. 5000 w. Sib Jour of Engng—May, 1900. No. 34487 C.

Ignition.

The Gas-Engine Hot-Tube as an Ignition Timing Device. William T. Magruder. A record of data and results of a series of gas-engine tests at the Ohio State Univ. 4000 w. Trans Am Soc of Mech Engs, No. 859—May, 1900. No. 34099 C.

STEAM ENGINEERING.

Auxiliaries.

Steam Plant Auxiliaries. P. C. Percy. Discusses feed pumps of various types. 1900 w. Am Elect'n—June, 1900. No. 34454.

Balancing.

On Balancing of Steam Engines. Otto Schlick. Read before the Inst. of Naval Archts. Discusses the method of finding the balance for a four-crank engine. 2200 w. Engng—April 20, 1900. No. 33945 A.

Binary Vapor Engine.

The Behrend-Zimmermann Binary-Vapor Engine. A description of an engine invented by G. Behrend and Dr. Zimmermann, and improved by Prof. Josse, in which the heat of exhaust steam evaporates sulphurous acid and the cold vapor thus generated does work in an auxiliary cylinder amounting to half the power developed in the steam cylinders. 1100 w. Eng Rec—May 5, 1900. No. 33996.

The Behrend-Zimmermann Cold Vapour Engine (Die Behrend-Zimmermannsche Kaltdampfmaschine). An account of Prof. E. Josse's experiments with an engine in which the heat of the exhaust steam is utilized in evaporating another liquid having a lower boiling point than water. 1400 w. Stahl und Eisen—April 15, 1900. No. 34129 D.

Boilers.

The Manipulation of Boiler Plates. Substance of replies in response to a circular, giving quite a complete account of the handling of plates. 1800 w. Ry Age—May 25, 1900. No. 34440.

See also Electrical Engineering, Generating Stations.

Coal Handling.

See Electrical Engineering, Generating Plant.

Cylinder Proportions.

Cylinder Proportions for Compound and Triple-Expansion Engines. Bert. C. Ball. Presented at Junior meeting, March 6, 1900. A discussion of this question, and of the drawing of indicator diagrams by these engines. 4500 w. Trans Am Soc of Mech Engs, No. 857—May, 1900. No. 34097 C.

Engine Breakage.

Some Strange Breakages. John E. Sweet. Illustrated description of interesting examples. 800 w. Am Mach—May 17, 1900. No. 34307.

Engines.

See Electrical Engineering, Generating Stations.

Explosion.

A Landslide Explodes a Boiler. Illustrates and describes the circumstances under which an explosion occurs at Rosendale, N. Y. 1100 w. Locomotive—March, 1900. No. 34486.

Feed Water.

The Purification of Boiler Feed Water. An explanation by Albert A. Cary in reply to a correspondent, regarding the fitting of the tubes on the water side in the boilers. 4000 w. Power—May, 1900. No. 33960.

Water-Softening Plant at the Lorain Steel Company's Blast Furnaces. N. O. Goldsmith. Illustrates and describes the plant and the conditions necessary for accurate and uniform treatment, and other points of importance. 2400 w. Trans Am Soc of Mech Engs, No. 863—May, 1900. No. 34202 C.

Boiler Feed-Water Treatment. W. H. Edgar. Topical discussion at meeting of the Western Ry. Club. 3500 w. Ry & Engng Rev—April 28, 1900. No. 33932.

Feed-Water Heaters.

Live-Steam Feed-Water Heaters. W. F. Durand. Considers the relation of the live-steam heater to the heat losses, concluding that their use is favorable to economy. 2800 w. Am Elect'n—May, 1900. No. 33938.

Governors.

Shaft Governors. J. C. Cornock. Illustrates and describes various forms, and explains the method of control in part first. 3000 w. Prac Engr—May 4, 1900. Serial. 1st part. No. 34271 A.

Liquid Fuel.

The Utilization of Liquid Fuels (Utilisation des Combustibles Liquides). H. Guérin. A general review of an article by H. Tweddle, in the *Engineering and Mining Journal,* with original matter. Illustrations and tables. Serial. 1st part. 3500 w. Génie Civil—May 12, 1900. No. 34187 D.

Marine Engines.

On the Uniformity of Turning Moments of Marine Engines. Dr. Lorenz. Read before the Inst. of Naval Archts. Arguing that the balance of the reciprocating masses agrees well with the conditions for the most uniform possible diagram of turning moments, and is necessary for attaining a good uniformity of the angular velocity of the crank shaft. 1500 w. Engng—April 20, 1900. No. 33944 A.

Pumping-Engine.

A Test of a Fifteen-Million High-Duty Pumping Engine at Grand Rapids, Mich. M. E. Cooley and F. C. Wagner, and J. R. Allen. Describes the boiler, engine, pumps, preparations for tests, apparatus used, etc., the tests and results. Ill. 20000 w. Trans Am Soc of Mech Engs, No. 855—May, 1900. No. 34095 C.

Pumping-Engine Test with Superheated Steam. E. H. Foster. Describes a duty test of a small pumping engine at the city water-works in St. Albans, England, giving results. 1000 w. Trans Am Soc of Mech Engs, No. 865—May, 1900. No. 34204 C.

Tests of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company. W. F. M. Goss. Illustrated description of the engine, with account of the test and results. 6500 w. Trans Am Soc of Mech Engs, No. 862—May, 1900. No. 34201 C.

Reheaters.

Reheaters in Multiple Cylinder Engines. R. H. Thurston. A review of what is already known of this subject, and conclusions. 5200 w. Trans Am Soc of Mech Engs, No. 856—May, 1900. No. 34096 C.

Scale.

A Simple and Successful Scale Prevention Method. Illustrates and describes the system of J. G. Talmage, which is pronounced to be successful when properly operated. 1600 w. Am Engr & R R Jour—May, 1900. No. 33953 C.

Speed.

Speed Regulation of Engines. G. J. Wells. Read before the Brit. Assn. of Draughtsmen. Part first investigates the causes of variations in the mean effective pressure, and illustrates by taking a case from practice. Ill. 1800 w. Prac Engr —April 27, 1900. Serial. 1st part. No. 34052 A.

Steam Engines.

How the Common Syringe Became the Steam Engine. Robert L. Galloway. Traces the mechanical evolution. 2200 w. Col Guard—April 20, 1900. Serial. 1st part. No. 33913 A.

Steam Turbine.

Westinghouse-Parsons Steam Turbine Plant. Burcham Harding. Illustrated description of steam turbine plants now in use in American works, with notes on their efficiency in regular service. 3500 w. Eng Rec—May 5, 1900. No. 33998.

The Efficiency of the Direct-Coupled Steam Turbine. Ed. C. de Segundo. On the achievement, from the point of view of relative efficiency, of the improved steam turbine of the Westinghouse Co. 600 w. Elec Rev, Lond—April 27, 1900. No. 34055 A.

Stoking.

See Electrical Engineering, Generating Stations.

Tests.

The Rating of Steam Engines by Their Steam Consumption (Die Beurteilung der Dampfmaschine hinsichtlich ihres Dampfverbrauches). E. Meyer. Review and explanation of the rules recently adopted by the *Verein Deutscher Ingenieure*, etc.; and the full report of the Institution of Civil Engineers' Committee on Rules for Determining the Utilization of Heat in Steam Engines. Serial. 1st part. 6000 w. Zeitschr d Ver Deutscher Ing—April 28, 1900. No. 34106 D.

Standard Rules for Testing Steam Boilers and Engines (Normen für Leistungsversuche au Dampfkesseln und Dampfmaschinen). Specifications adopted by the *Verein Deutscher Ingenieure* and the *Verein Deutscher Maschinenbauanstalten*, and under consideration by the International Association of Steam Boiler Inspectors. 3000 w. Zeitschr d Ver Deutscher Ing—April 7, 1900. No. 34105 D.

MISCELLANY.

Aeronautics.

Count von Zeppelin's Air-Ship. Illustrated description, and discussion of this large dirigible air ship. 1000 w. Sci Am —May 26, 1900. No. 34403.

Armaments.

Machine Guns of Calibre. An explanation and discussion of armaments used in the South African war. 2300 w. Engr, Lond—May 11, 1900. No. 34368 A.

Armored Trains.

Armored Traction Trains for South Africa. Information concerning these trains, and their usefulness, reporting a successful trial run. 2300 w. Engng—May 18, 1900. No. 34466 A.

Brick Manufacture.

The Roller-Pallet System for the Manufacture of Bricks. Clemens Catesby Jones. Gives a brief account of prevailing industrial conditions and practice, describing the best modern system of drying, and presenting a mechanical process and its advantages. 4200 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34035 D.

Disappearing Carriages.

Disappearing Gun Carriages in the United States. G. H. Powell. A description, by the Secretary of the Board of Ordnance, of the mountings which distinguish the U. S. coast defences from those of Europe. 1800 w. The Engineering Magazine—June, 1900. No. 34489 B.

Eccentric Loading.

Cases of Eccentric Loading. G. A. Goodenough. Discusses cases arising in practice, investigating the stresses. 3500 w. Tech, No. 14—1899-1900. No. 34383 D.

Export Trade.

The Follies of Some American Exporters. By a Continental Salesman. An arraignment of the fatuous methods of some would-be sellers in European markets, on a contrasting exposition of the careful efforts of German machinery makers. 3500 w. The Engineering Magazine—June, 1900. No. 34493 B.

Fuel.

Liquid Fuel in Europe. On the growing use, and the increased production. 600 w. U. S. Cons Repts, No. 731—May 16, 1900. No. 34273 D.

German Patents.

Decision of the Imperial Court on the Invalidity of Patents on Inventions Which Have Been the Subject of an Earlier Patent (Entscheidung des Reichsgerichts über Nichtigkeit von Patenten auf Grund des Sec. 10 Abs. 2 des Patentgesetzes). Full text of the decision, declaring void patents on inventions which have been covered by earlier patents, even though the earlier patent has expired. 4500 w. Glaser's Annalen—April 1, 1900. No. 34101 D.

Germany.

Report on the Economic Position of the German Empire in 1900 by Mr. Gastrell, Commercial Attaché to Her Majesty's Embassy at Berlin. Considers Germany's important position, development of trade, maritime interests, present commercial policy, finances, expenditure of army and navy, with many tables for comparison.

10800 w. Brit Dip & Cons Repts, No. 2400—April, 1900. No. 34215 D.

Gun.

The Genesis of the Magazine Shoulder Gun. E. G. Parkhurst. Illustrated detailed description and history of the John Cookson gun, made in 1586. 1600 w. Am Mach—May 17, 1900. No. 34304.

International Congress.

International Congresses at the Paris Exposition in 1900 (Internationale Congresse gelegentlich der Weltausstellung zu Paris, 1900). A list of the various congresses, with dates and addresses of the respective presidents and secretaries. 2000 w. Glaser's Annalen—April 15, 1900. No. 34120 D.

Metric System.

Progress of the Metric System in the United States. Abstract of the report of the committee on the metric system, presented at the Chicago meeting of the Am. Ry. Assn., showing its use to be confined to concerns which export to metric countries. 1300 w. Eng News—May 10, 1900. No. 34229.

Paris Exposition.

The Paris Exposition as a Mechanical Achievement. Edmund Mitchell. A review of the system, organization and plan of this stupendous undertaking, and a survey of the general result. 3600 w. The Engineering Magazine—June, 1900. No. 34490 B.

The Paris Exposition (Die Pariser Weltausstellung). A general illustrated description, with particulars of some engineering features. Two articles. 4500 w. 1 plate. Stahl und Eisen—April 15, May 1, 1900. No. 34123 each D.

The United States Sections at the Paris Exposition (Exposition Universelle de 1900. La Participation des Etats-Unis). Aym. de Marolles. A general account of the space occupied by, and the officials of the United States. 2400 w. Revue Technique—April 25, 1900. No. 34480 D.

Smoke.

Smoke Abatement. E. A. Brayley Hodgetts. A discussion of the smoke question and the remedy. 2000 w. Jour San Inst—April, 1900. No. 34239 E.

The Smoke Nuisance and the Medical Officer of Health. Joseph Priestley. Reviews acts dealing with smoke in Great Britain. 2000 w. Jour San Inst—April, 1900. No. 34240 E.

Weighbridges.

Large Weighbridges. Illustrated description of a 110-ton railway weighbridge made for a large marine engineering firm, and a large hot iron plate weighing machine. 1400 w. Engr, Lond—May 4, 1900. No. 34257 A.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Prevention of Accidents in Connection with Mine Passes. Victor Watteyne. From a communication to the *Annales des Mines de Belgique*. Part first considers accidents that occurred while the pass was being cleared of obstruction from below and from above. Ill. 1800 w. Col Guard—May 11, 1900. Serial. 1st part. No. 34375 A.

Caging.

Mechanical Caging at the Commentry Colliery. Illustrated description of the arrangement. 1100 w. Col Guard—May 11, 1900. No. 34378 A.

China.

The Coal Fields Around Tsê Chou, Shansi, China. Noah Fields Drake. Information concerning this famous region, the manner of working and transporting the coal, and matters of related interest. Ill. 3500 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34029 D.

Coal Cells.

Coal Cell Trade. George Johnson. An explanation of the manner of working coal cells provided for retail sale of coal. 1000 w. Col Guard—May 11, 1900. No. 34374 A.

Coal Supply.

The Coal Famine and the Public. From the London *Times*. Discusses the causes of the recent scarcity and high cost of fuel all over the world. 4000 w. Jour Gas Lgt—April 24, 1900. No. 33947 A.

Coal Working.

Coal Mining by Mechanical Appliances. James Warne Chenhall. Describes the working of the Cambria Mining Co.'s Plant at Cambria, Wyoming, U. S. A. 3500 w. Col Guard—May 11, 1900. No. 34376 A.

Working Twin Seams of Coal. W. S. Gresley. Descriptions of methods which have come within the writer's observation. Ill. 3000 w. Eng & Min Jour—May 12, 1900. Serial. 1st part. No. 34224.

Electric Plant.

New Electric Plant at the Blanzy Colliery. M. Goichot. From a communication to the Société de l'Industrie Minérale. Illustrated description of the plant and the appliances for utilizing the current for motive power. 3300 w. Col Guard—April 20, 1900. No. 33914 A.

Explosion.

The Mine Explosion at Scofield, Utah. An account of one of the most serious disasters of modern times, causing the loss of over 250 lives. 1500 w. Eng & Min Jour—May 12, 1900. No. 34222.

Explosives.

Use of Safety Explosives in Fiery Mines. M. L. Aguillon. From a report on behalf of the French Firedamp Commission. Considers the regulations to which safety explosives are subject in France, and the need of having the composition printed on all the cartridges used in fiery mines. 3500 w. Col Guard—May 4, 1900. No. 34265 A.

Faults.

A Peculiar Fault and a Problem in Coal Mining. Arthur Lakes. An illustrated description of a coal seam thrown a half mile horizontally out of position. 1000 w. Mines & Min—May, 1900. No. 34004 C.

Gob-Fires.

The Standard Theory of Gob-Fires. H. W. Halbaum. A statement of what mining engineers believe in regard to such phenomena as gob-fires. Attributes them to spontaneous combustion, explaining the manner, and discussing the prevention and extinction. 6700 w. Col Guard—April 27, 1900. No. 34067 A.

Haulage.

See under Mining, below.

Natal.

The Coal Industry in Natal. Reviews the history of the industry, and considers the future prospects most promising. 1200 w. Col Guard—April 20, 1900. No. 33916 A.

New Plant.

New Plant at Broomhill Colliery. John E. O'Keefe. From the *Journal of the British Society of Mining Students.* Brief description. 800 w. Col Guard—May 18, 1900. No. 34474 A.

Prospectus.

Russia's Lack of Coal (Crise Houillère spectus. George Johnson. Considers points which occur in negotiations for the acquirement of mining property, and in the preparation of the prospectus when the business takes the form of a limited liability company. 2000 w. Col Guard—April 20, 1900. No. 33917 A.

Russia.

Russia's Lack of Coal (Crise Houillére en Russie). An account of the scarcity of coal in Russia, the lowering of the customs duties, discussion of ways and means to increase the domestic supply and tables showing imports in recent years. 1000 w. Moniteur Ind—April 14, 1900. No. 34194 E.

Sidings.

Colliery Sidings and Agreements. George Johnson. A discussion of the chief factors to be considered. 2200 w. Col Guard—May 18, 1900. No. 34473 A.

Under Sea.

The Working of Coal Mines Under Sea. Thomas Bell. Read before the Manchester Geol. Soc. Concerning the depth and extent to which the coal mines have been worked under the sea off the coast of Durham and Northampton; also under the permian feeder of water, in the county Durham. 2800 w. Ir & Coal Trds Rev. and Col Guard—May 4, 1900. Serial. 1st part. No. 34261 A.

Western Coal.

The Geological Position of Trans-Mississippian Coal. Charles R. Keyes. Information obtained during recent investigations concerning the stratigraphical position of seams, and other features. 1900 w. Eng & Min Jour—May 5, 1900. No. 34080.

COPPER.

Arizona.

The Ray Copper Mines, Arizona. Alexander Hill. An account of the location and development of these deposits, with plan of workings and percentage of copper found in assays taken at different points. 1900 w. Eng & Min Jour—May 19, 1900. No. 34341.

Assaying.

See Gold and Silver, below.

Butte.

The Mines of Butte. Arthur Lakes. A description of the Gagnon mine, the Original mine and the Stewart mine; the ores as they are found and the formations of the veins; the plants for hoisting and handling them and for preparing the mine timber. Ill. 2500 w. Mines & Min—May, 1900. No. 34014 C.

Cuba.

El Cobre Mines, Cuba. Illustrations and brief account of these copper mines, located 12 miles west of Santiago. 450 w. Eng & Min Jour—May 19, 1900. No. 34339.

GOLD AND SILVER.

Assaying.

The Assay of Copper-Materials for Gold and Silver. L. D. Godshall. Brief review of two methods used and description of a method recommended by the writer. 900 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34033 D.

Australia.

The Northern Territory. F. D. Holland. Illustrated description of the auriferous reefs of the Northern Territory of South Australia. 1200 w. Aust Min Stand—April 5, 1900. Serial. 1st part. No. 34209 B.

British Columbia.

The Atlin Gold Fields of British Columbia. J. H. Brownlee. Illustrated description of the conditions and prospects. 2000 w. Min & Sci Pr—May 19, 1900. No. 34402.

The Atlin District. William Baillie. An illustrated account of the discovery, giving the results of work done, and the prospects for the future. 3800 w. B. C. Min Rec—May, 1900. No. 34275 C.

Cape Nome.

Some Notes on the Nome Gold Region of Alaska. F. C. Schrader and Alfred H. Brooks. Describes the region, the deposits, the difficulties to be met, etc. Map. 4000 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34031 D.

The Gold Deposits of Cape Nome. Charles G. Yale. Information concerning those beach deposits, and their probable origin, means of working, etc. 1700 w. Sci Am Sup—May 12, 1900. No. 34213.

Gold Deposits and Mining Methods at Cape Nome. Information concerning the location, devices or power machines used, etc. Ill. 1400 w. Sci Am—May 19, 1900. No. 34295.

Concentration.

Small Mine Concentration. S. I. Hallett. Sketches of two mills, one having a capacity of from 12 to 25 tons in 24 hours, the other from 35 to 50 tons, with description. 2200 w. Min & Sci Pr—May 5, 1900. No. 34205.

Cyanide Plant.

Cyanide Plant at the Octave Mine, Weaver, Ariz. Illustrated description of a MacArthur-Forest cyanide plant for treating tailings, showing how simple a plant can be when no protection from the weather is necessary. 700 w. Min & Sci Pr—April 28, 1900. No. 33984.

Dikes.

A Peculiar Clastic Dike near Ouray, Col., and Its Associated Deposit of Silver Ore. F. L. Ransome. Illustrated description of a deposit of unusual character. 1600 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34036 D.

Ecuador.

Notes on the Gold Mines of Zaruma, Ecuador. J. Ralph Finlay. A general description of the mines and methods of mining, lumbering, etc. Ill. 3000 w. Trans Am Inst of Min Engs—April, 1900. No. 34030 D.

Extraction.

Gold Extraction Processes and New Solvents. J. Ohly. Part first describes the process of M. de Rigaud, and the substitution of bromine for chlorine in the chlorination process. 1400 w. Min Rept—April 26, 1900. Serial. 1st part. No. 33948.

Mexico.

Mining and Smelting in the State of Durango, Mexico. H. Van F. Furman. An illustrated description of the mines and some peculiar problems met with in smelting. 3000 w. Mines & Min—May, 1900. No. 34002 C.

Ores.

An Examination of the Ores of the Republic Gold Mine, Washington. T. M. Chatard and Cabell Whitehead. A report of investigations, showing the importance of thorough chemical examination of such gold-ores as do not readily yield their values. 1500 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34034 D.

Philippines.

Gold in the Philippines. William Gilbert Irwin. Brief account of such researches as have been made in the Island of Luzon, and the promising outlook. 800 w. Eng & Min Jour—May 19, 1900. No. 34340.

Smelters.

Smelters and Reduction Works of the Northwest. Arthur Lakes. Facts in regard to the location and capacities of the various works. 2000 w. Mines & Min—May, 1900. No. 34013 C.

Stamp Milling.

Water and Fuel Economy in Stamp Milling. A. W. Warwick. Facts and figures concerning the minimum amount of water that will supply a 10-stamp mill. 1200 w. Eng & Min Jour—May 5, 1900. No. 34081.

Washington.

The Lone-Pine-Surprise-Consolidated Mines, Republic, Washington. M. H. Joseph. An illustrated account of these mines and the value of the ore already blocked out. 2700 w. Eng & Min Jour—May 26, 1900. No. 34438.

IRON AND STEEL.

Annealing Furnace.

Steel Plate Annealing Furnace (Flusseisenblech-Glühofen. Hen. Wdowiszewski. Abstract of a Russian article by Director J. Q. Rayner of the Kulebaki iron works near Nijni Novgorod, giving an illustrated account of an annealing furnace there. 800 w. Stahl und Eisen—May 1, 1900. No. 34131 D.

Armor.

Manufacture of Guns and Armor at the Bethlehem Steel Works. An illustrated description of the open hearth process. 2000 w. Sci Am—May 19, 1900. No. 34294.

Blowing Engines.

See Mechanical Engineering, Special Motors.

British Columbia.

Iron Ore Deposits of Vancouver and Texada Islands. William M. Brewer. An account of rich deposits which have received little attention. 1200 w. Eng & Min Jour—May 5, 1900. No. 34079.

Canada.

Canada: Its Iron Resources and Possibilities. Walter R. Nursey. Information concerning the deposits in Canada, their richness and extent. 3800 w. Ir & Coal Trds Rev—April 27, 1900. No. 34058 A.

Concentrating.

Concentrating Lake Superior Ore. L. M. Hardenburgh. Paper read at the Lake Superior Mining Inst. on the treatment of lean Pewabic ore. 1000 w. Am Mfr & Ir Wld—May 10, 1900. No. 34289.

Georgia Iron Ores.

Geological Relations of the Iron-Ores in the Cartersville District, Georgia. C. Willard Hayes. Illustrates and describes the stratigraphy and structure of this region and the ore deposits. 6000 w. Trans Am Inst of Min Engs—Feb., 1900. No. 34038 D.

German Statistics.

Statistics (Statistisches). Tables giving German exports and imports for January and February, 1899 and 1900; iron consumption, 1861-1899; and the production of mines and iron works in 1899. 1500 w. Stahl und Eisen—May 1, 1900. No. 34134 D.

Hot Blast.

The Equalization of the Varying Temperatures of Hot Blast. Lawrence F. Gjers and Joseph H. Harrison. Read before the Iron and Steel Inst. Illustrated description of apparatus which delivers the blast at an even mean temperature. 1300 w. Col Guard—May 11, 1900. No. 34373 A.

Liquid Fuel.

The Utilization of Liquid Fuels for Metallurgical Purposes in Russia (Verwendung von Flüssigem Brennstoff für Hüttenmännische Zwecke in Russland). J. Preiner. An illustrated account of methods of using naphtha in metallurgical furnaces. 2400 w. Stahl und Eisen—April 15, 1900. No. 34127 D.

Liquid Fuel in Russian Iron Works. J. Preiner, in *Stahl und Eisen.* Illustrates and describes the methods of burning the fuel, and some idea is given of the expense. Russian petroleum is described, and its extensive use reported. 3000 w. Col Guard—April 27, 1900. No. 34068 A.

Open Hearth.

The Open-Hearth Continuous Steel Process. Benjamin Talbot. Read before the Iron and Steel Inst. Describes this process as worked at the Pencoyd Steel Works, at Pencoyd, Pa., and a statement of the advantages. Discussion. 9000 w. Ir & Coal Trds Rev—May 11, 1900. No. 34379 A.

The Use of Fluid Metal in the Open-Hearth Furnace. James Riley. Read before the Iron and Steel Inst. A discussion of this process and its advantages, and the opinion that eventually this process will prevail. 4200 w. Engng—May 11, 1900. No. 34355 A.

A New Process for the Production of Basic Open-Hearth Steel from Pig and Ore. Ambrose Monell. A description of this process, also calling attention to other developments in metallurgy. 3500 w. Ir & Coal Trds Rev—May 11, 1900. No. 34380 A.

Pig Iron.

Pig Iron Breakers. T. E. G. Marley describes the machine at the works of the Whitehaven Hematite Iron & Steel Co., Ltd., and Enoch James the hydraulic machine used at the Dowlais Works. Ill. 2800 w. Col Guard—April 20, 1900. No. 33918 A.

Riddles.

Riddles Wrought in Iron and Steel. Paul Kreuzpointner. Considers some of the puzzling problems encountered, and the manifestations which are apparently the source of many of them. Discussion. Ill. 11400 w. Jour Fr Inst—May, 1900. No. 34092 D.

Slag.

The Utilization of Blast-Furnace Slag Cecil von Schwarz. Read before the Iron and Steel Inst. Briefly describes a method recently employed in Germany and Belgium for manufacturing cement out of slag, which has given the best results as to strength and reliability. 1700 w. Col Guard—May 11, 1900. No. 34377 A.

Specifications.

Standard Specifications for Steel and Iron. A set of specifications for steel for bridges, buildings, and ships, and for wrought iron; with an editorial discussion of the value of the work done by the Am. Sec. of the International Assn. for Testing Materials in preparing them. 2500 w. Eng Rec—May 19, 1900. No. 34329.

Standard Specifications for Materials. The first of a series of articles publishing important tables and giving synopses of proposed specifications of the Am. Sec. of the International Assn. for Testing Materials. 2000 w. R R Gaz—May 11, 1900. No. 34233.

The Proposed American Standard Specifications for Steel. A review of these important specifications. 6500 w. Ir Age—May 17, 1900. No. 34285.

Sweden.

Sweden's Wealth in Iron Ore (Schwedens Eisenerzschätze). Abstract of an article in *Jernkontorets Annalen* by C. Nordenström, giving statistical information, with tables. 1500 w. Stahl und Eisen—May 1, 1900. Serial. 1st part. No. 34132 D.

Wire Mills.

New Trains of Rolls (Neue Walzstrassen). Edm. Weber. A description, with diagrams, of arrangements of rolls for the economical production of wire. 1500 w. Stahl und Eisen—April 15, 1900. No. 34126 D.

MINING.

China.

Present Situation of the Mining Industry in China. H. C. Hoover. Information relating to the regulations and concessions affecting the mining industry. 2000 w. Eng & Min Jour—May 26, 1900. No. 34439.

Dams.

See Civil Engineering, Hydraulic and Marine.

Deep Mining.

Deep Mining at the Utica Mine, Angels, California. J. H. Collier, Jr. Gives an outline of the general nature of the deposit and the difficulties of mining, shaft sinking, etc., with detailed explanation of the excavation of the ore. Ill. 6500 w. Trans Am Inst of Min Engs—Sept., 1900. No. 34039 D.

Electric Power.

Electricity Applied to Mining. Harold Bentham. Read before the Manchester Soc. of Jun. Elec. Engs. Considers the advantages and disadvantages of steam and electricity as motive power, and the lighting. Ill. 2100 w. Elec Engr, Lond —May 11, 1900. Serial. 1st part. No. 34360 A.

Electricity in Mining. R. B. Williamson. Considers the principles governing the calculation, construction, and operation of electrical installations, giving explanation of electrical units, circuits, resistances in series and multiple, electric wiring, etc. 3000 w. Mines & Min—May, 1900. Serial. 1st part. No. 34011 C.

The Electric Central Station for Power and Light at the Margarethe Mine at Sölde, Westphalia (Die Elektrische Centrale für Kraftübertragung und Beleuchtung auf der Zeche Margarethe bei Sölde i. Westf.). A short account of the plant, which furnishes power and light for the mine, and also for the surrounding district. 1000 w. Glückauf—May 5, 1900. No. 34153 B.

Electric Pumps.

Electrically Driven Mining Pumps (Elektrisch Betriebene Bergwerkspumpen). A well illustrated account of various electric pumps at mines in Germany and Austria. Two articles. 3000 w. Glückauf—April 28, May 5, 1900. No 34-152 each B.

Electric Winches.

Electrically Driven Hauling Winches (Ueber Elektrisch Betriebene Förderhaspel). Wilhelm Müller. An illustrated account of some electric winches at mines in the Ruhr coal district, Westphalia. 3 plates. 6000 w. Glückauf—April 21, 1900. No. 34151 B.

Explosives.

British and American Explosives. A Comparison. Considers the legislative restrictions and the benefits in the United Kingdom, the names given, the profits, etc. 1200 w. Col Guard—April 27, 1900. No. 34066 A.

Fans.

Comparative Tests of a Rateau and a Guibal Fan. A report of tests under the same conditions, showing the superiority of the Rateau fan. 1000 w. Col Guard—May 4, 1900. No. 34267 A.

Haulage.

Electrical Winding and Haulage Machinery. W. Müller. Translated and abridged from *Glückauf*. Describes the electrical plants in use in the mines of the Ruhr coal district. Ill. 2800 w. Ir & Coal Tds Rev—May 18, 1900. Serial. 1st part. 34462 A.

Statistics of Rope Haulage in Shafts (Statistik der Schachtförderseile). Tables showing the life, efficiency, breakages, etc., of wire, hemp and other kinds of rope. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 12, 1900. No. 34-150 B.

Pit Ponies and Horse Haulage. F. Povey-Harper. Paper read before the British Soc. of Min. Students. Discusses the cost, care, etc. 1300 w. Ir & Coal Trds Rev—May 18, 1900. No. 34461 A.

Igniter.

Meinhard's Improved Igniter for Blasting Charges. From *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrated description of the apparatus, with results of experiments. 800 w. Col Guard—April 20, 1900. No. 33915 A.

Indicators.

Recording Indicators for Firedamp and

the Velocity of Air Currents. P. Fuchs, in *Zeitschrift für Berg-, Hütten-, und Salinenwesen.* Illustrated description of the apparatus employed for securing the records by the photographic method. 1500 w. Col Guard—May 4, 1900. No. 34266 A.

Labor.

Eight Hour Shifts and the Minimum Wage in Mining (Ueber die Achtstundenschicht und den Minimallohn beim Bergbau). W. Jicinsky. A general discussion of the labor question in Austrian mines. 4400 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 28, 1900. No. 34146 B.

Is It Advisable to Introduce Nine Hour Shifts at all Coal Mines (Ist es Rathsam, bei Sämmtlichen Kohlenbergbauen die Nuenstündige Schichtdauer Einzuführen)? Carl Balling. Discussion of the effect on production and prices, in Austro-Hungary. 3200 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 14, 1900. No. 34145 B.

Mine Accidents.

The Want of Forethought.—The Causes of Mine Accidents. R. M. Haseltine. Read before the Ohio Inst. of Min. Engs. Describes peculiar accidents arising from conditions which have only recently existed in mines. 1500 w. Mines & Min—May, 1900. No. 34008 C.

Mine Engine.

An Old Mine Engine. K. Müller. *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Brief illustrated description of engine constructed in 1813 and used in Bohemia. 900 w. Col Guard—April 27, 1900. No. 34063 A.

Mining Law.

Abandonment of Leased Mines. Facts of several cases and the adjudications in the same in the United Kingdom. 4700 w. Col Guard—April 27, 1900. No. 34064 A.

Mining Methods.

Method of Mining at the Badger Mine, Commonwealth, Wis. O. C. Davidson. Read before the Lake Superior Mining Inst. Describes the methods used and the difficulties met. The maximum product attained in one month was 38,000 tons. 800 w. Mines & Min—May, 1900. No. 34007 C.

Sardinia.

Progress in Ore Preparation Processes in Sardinia (Fortschritte der Erzaufbereitung in Sardinien). Erminio Ferraris. Description of swinging sieves used in sorting ores. 1600 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 5, 1900. No. 34147 B.

Shafts.

Sinking Shafts by Means of the Poetsch Freezing Method (Die Abteufung von Schächten mittels des Poetsch'schen Gefrierverfahrens). F. H. and Walter Poetsch. A long description of practical experience with this method of solidifying quicksand and other loose materials, so that shafts can be sunk through them. Four articles. 8000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 14, 21, 28, May 5, 1900. No. 34144 each B.

Simultaneously Sinking, Lining, and Fitting a Shaft with Guides. M. Bouteille. From a communication to the Société de l'Industrie Minérale. Illustrated detailed description of interesting work. 4200 w. Col Guard—April 27, 1900. No. 34065 A.

Signals.

Electric Signals at West Vulcan. A. W. Thompson. Read before the Lake Superior Mining Inst. Considers peculiarities in their construction and the experiences which showed their necessity. 1500 w. Mines & Min—May, 1900. No. 34005 C.

MISCELLANY.

Arsenic.

The British Arsenic Industry. Some facts relating to the methods used in the manufacture of arsenic from the ore, and the effect upon the workmen. 2500 w. Engng—May 4, 1900. No. 34248 A.

Austro-Hungary.

Austro-Hungarian Foreign Trade in Mining and Metallurgical Products for 1899 (Der Auswärtige Handel des Oesterreichisch-Ungarischen Zollgebietes in Waaren der Montanindustrie im Jahre 1899). Dr. Moritz Caspaar. A general account, with statistical tables. Two articles. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 5, 12, 1900. No. 34148 each B.

Borax.

Borax—Old and New Methods of Production. Illustrated account of the deposits in the United States and the methods used. 1000 w. Sci Am—May 26, 1900. No. 34404.

German Statistics.

Comparative Statistics of the German Patent Office for 1899 (Vergleischende Statistik des Kaiserlichen Patentamtes für das Jahr 1899). Tables giving general statistics, with some details of the mining and metallurgical classes. 700 w. Stahl und Eisen—May 1, 1900. No. 34133 D.

Manganese.

The Manganese Ores of Brazil. Herbert Kilburn Scott. Read before the Iron and Steel Inst. Describes the position and geology of the deposits, and gives a brief outline of the history of manganese mining, and other information of interest. 5700 w. Col Guard—May 18, 1900. No. 34472 A.

Nickel.

Some Novelties in Nickel Metallurgy (Ueber Einige Neuerungen in der Metallurgie des Nickels). Prof. Ed. Donath and B. M. Margosches. A long article on nickel ores and their metallurgy. Serial. 1st part. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 12, 1900. No. 34149 B.

Petroleum.

Prospecting for Petroleum in California. A. S. Cooper. Abstract from "Bulletin No. 16," California State Mining Bureau. Directions for prospectors, indications of the presence, tests, etc. 1200 w. Eng & Min Jour—May 12, 1900. No. 34223.

Salt.

Salt Mines of Avery's Island, Louisiana. Henry Romeyn. A description of the works and the interesting geological formation. 2500 w. Mines & Min—May, 1900. No. 34003 C.

The Salt Wells of Szchuan, China. W. M. Upcraft. Illustrated description of the peculiar methods of an important industry. 700 w. Eng & Min Jour—May 5, 1900. No. 34078.

Smelting.

The Smelting of Dubuque Ores. H. Foster Bain. History of the industry, the methods in use, and some observations on making spelter at Dubuque. 1700 w. Mines & Min—May, 1900. No. 34015 C.

Tin.

Blue Tier Tin Mining (T.). H. Grant. Information concerning the Anchor Mine. 1300 w. Aust Min Stand—March 29, 1900. No. 34207 B.

The Planet Tin Mines. Information concerning this Australian source of suppl. 900 w. Aust Min Stand—April 5, 1900. No. 34208 B.

Yosemite.

Glacial Erosion and the Origin of the Yosemite Valley. William P. Blake. Considers the mining action of glaciers, the enormous glaciation in California, the origin of the Yosemite, and sub-glacial erosion generally. Ill. 4200 w. Trans Am Inst of Min Engs—Sept., 1899. No. 34037 D.

Zinc.

The Joplin Zinc District. F. Lynwood Garrison. Regarding its location, the ores, and the formations in which they occur; the methods of mining and marketing. 2600 w. Mines & Min—May, 1900. No. 34012 C.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accident.

The Collision at Park Tunnel, Philadelphia. Facts concerning an accident on the B. & O., at Philadelphia, May 11, followed by an explosion of oil cars that blocked the tunnel for three days. 800 w. R R Gaz—May 25, 1900. No. 34417.

Freight Trains.

Handling Long Freight Trains on Mountain Grades. From a committee report presented at the Jacksonville meeting of the Assn. of Ry. Air Brake Men. 1800 w. Ry Mas Mech—May, 1900. No. 34302.

New South Wales.

Railway Practice in N. S. W. H. B. Howe. Presidential address to the Engng. Assn. of N. S. W. Part first gives information relating to the engines used. 1800 w. Aust Min Stand—March 29, 1900. Serial. 1st part. No. 34206 B.

Safety Appliances.

Are Present Methods of Train Protection Adequate? C. E. Davis. Brief paper of general character followed by discussion. Ill. 12500 w. Jour W Soc of Engs—April, 1900. No. 33921 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Lubricating Air Brake Parts. From a report presented at the Jacksonville meeting of the Assn. of Ry Air Brake Men. 1800 w. Ry Mas Mech—May, 1900. No. 34303.

Cars.

A Convertible Box and Hopper Car. Illustrates and describes a car designed by W. T. Manning, adapted to various classes of freight ordinarily transported in cars of the two classes. 1000 w. Ry Age—May 25, 1900. No. 34441.

A Roadbed Trimming Car. Illustrated description of the general features of a car used on the Boston & Maine R. R. for a variety of purposes. 1000 w. Ry Age—May 18, 1900. No. 34346.

Classification and Numbering of Passenger and Freight Equipment. J. A. Gohen. Calls attention to the need of improvement, with suggestions. 1500 w. St. Louis Ry Club—May 11, 1900. No. 34445.

New Observation Buffet Cars for the Northern Pacific. Brief illustrated description of new cars to run between St. Paul and the Pacific coast. 300 w. Ry Age—April 27, 1900. No. 33927.

Coal Cars.

80,000 and 85,000-Pound Coal Cars. Illustrates and describes two new designs of wooden cars in use on the Buffalo, Rochester & Pittsburg Ry. They are known as the "shovel car" and the "dock car." 600 w. Am Engr & R R Jour—May, 1900. No. 33949 C.

Coke Car.

A Pressed Steel Coke Car. Illustrations and brief description of a car for the Chicago, Lake Shore & Eastern Ry. 250 w. R R Gaz—May 11, 1900. No. 34234.

Couplings.

Automatic Railway Couplings. Describes the first English train fitted throughout with automatic couplings, and the trial made, calling attention to interesting improvements. 1500 w. Engng—April 27, 1900. No. 34061 A.

Draft Gear.

The Westinghouse Friction Draft Gear. Illustrated description of this device and its operation. 1800 w. Am Engr & R R Jour—May, 1900. No. 33955 C.

Electric Power.

See Electrical Engineering, Power Applications, and Street and Electric Tramways.

Feed Water.

See Mechanical Engineering, Steam.

Flanges.

Prevention of Wear of Driving Wheel Flanges. Describes the arrangements adopted by different roads for overcoming this trouble, especially describing the practice on the D., L. & W. R. R., which has been successful in stopping the flange wear. 2500 w. Am Engr & R R Jour—May, 1900. No. 33951 C.

Flat Car.

Flat Car of 77,000 Lbs. Capacity, North Belgian Railway. An interesting example of fine car construction is illustrated and described. 1500 w. R R Car Jour—May, 1900. No. 34220.

Locomotive Performance.

Performance of the Cleveland Locomotive. Describes an experiment tried on the Intercolonial Ry. of Canada, applying a system of dual exhaust. 1000 w. Am Engr & R R Jour—May, 1900. No. 33954 C.

Locomotives.

A Locomotive Study. Edward Grafstrom. Illustrates a novel adaptation of the wide firebox to a fast passenger engine of the American type. Offered as a suggestion. 700 w. Am Engr & R R Jour—May, 1900. No. 33952 C.

British Locomotives at the Paris Exhibition. Illustrates two engines to be shown, giving brief notes concerning them. 500 w. R R Gaz—May 18, 1900. No. 34349.

Tractive Power of Two-Cylinder Compounds. C. J. Mellin. Describes the development of the tractive power of compound locomotives. 1000 w. Am Engr & R R Jour—May, 1900. No. 33957 C.

Caledonian Railway Passenger Locomotives. Illustrated detailed description of latest types, with account of some of the performances. 1000 w. Engng—May 18, 1900. Serial. 1st part. No. 34463 A.

Mogul Locomotive for the Great Northern Railway of England. View and dimensions of an engine to be exhibited by Baldwin Locomotive Works, at the Paris Exhibition. 500 w. R R Gaz—May 18, 1900. No. 34348.

Consolidation Locomotive, Austrian State Railways. Illustrated description with general dimensions. 500 w. Engr, Lond—May 18, 1900. No. 34470 A.

Atlantic Type Passenger Locomotive. Illustration and dimensions of one of ten locomotives recently built by the Baldwin Locomotive Works for the French State Railways. 300 w. Am Engr & R R Jour—May, 1900. No. 33956 C.

Brooks Ten-Wheel Passenger Locomotive, D., L. & W. Ry. Illustrates one of seven handsome engines recently delivered, noting points of interest. 600 w. Ry & Engng Rev—May 5, 1900. No. 34083.

Four-Cylinder Compounds. Illustrates the principal features in the construction of the designs of F. W. Webb, of the London & North Western Ry. 800 w. Am Engr & R R Jour—May, 1900. No. 33950 C.

Old Norris Freight Engines on the Pennsylvania Railroad. C. H. Carruthers. Illustrated description of engines built in 1854. 1200 w. R R Gaz—May 4, 1900. No. 33991.

Richmond Ten-Wheel Freight Locomotives, R., F. & P. Ry. Specifications, illustration, and comments. 600 w. Ry & Engng Rev—May 26, 1900. No. 34443.

Two Large Consolidation Locomotives. Illustrated detailed description of two large engines, with dimensions. 2200 w. Eng News—May 17, 1900. No 34311.

Shops.

See under Permanent Way and Buildings, below.

Siberian Train.

A Siberian Train-de-Luxe. From the St. Louis *Globe-Democrat*. Illustrations and description of the Russian idea of a fine train. 1500 w. R R Car Jour—May, 1900. No. 34221.

NEW PROJECTS.

Austria.

Plans for Building Several Austrian Railroads at the Cost of the Government, Particularly a Second Railway Connection with Triest (Die Projectierte Herstellung mehrerer Oesterreichischer Eisenbahnen auf Staatskosten insbesonders eine Zweite

Eisenbahnverbindung mit Triest). The full official report on the project, with maps. Serial. 1st part. 2 plates. 19000 w. Oest Monatschr f d Oeff Baudienst—May, 1900. No. 34155 G.

Bagdad Ry.

The German Bagdad Railway. Considers the routes, the difficulties, and the greatness of the enterprise. Map. 1500 w. Engr, Lond—May 11, 1900. No. 34370 A.

British Columbia.

The Canadian Pacific Railway, from Laggan to Revelstoke, British Columbia. William S. Vaux, Jr. Briefly reviews the history of the transcontinental line of the Canadian Pacific Ry., and calls special attention to interesting features in the section named. Map and illustrations. 4200 w. Pro of Engs' Club of Phila—May, 1900. No. 34297 D.

Connecting Roads.

Certain "Connecting" Railroads in New York City. An account of the projects for connecting the New York Central & Hudson Riv. with the Long Is. Railroad, and the tunnel road to connect the roads terminating in New Jersey, with the Long Is. R. R. Ill. 700 w. R R Gaz—May 11, 1900. No. 34236.

Extension.

Completion of the Atchison to San Francisco. An account of the San Francisco and San Joaquin Valley, a proprietary line forming a connecting link for a great transcontinental line to the Pacific metropolis. 1200 w. R R Gaz—May 4, 1900. No. 33989.

Siberian Ry.

The Great Siberian Railway. M. Mikhailoff. An interesting review of this work, the resources of the country, and the effect upon the development. Map. 7000 w. N Am Rev—May, 1900. No. 33987 D.

West Virginia.

New Railroads in West Virginia. An account of new projects and extensions under contract or construction. 1200 w. R R Gaz—May 11, 1900. No. 34235.

PERMANENT WAY AND BUILDINGS.

Block-Signals.

Block-Signal System for Single-Track Railroads (Streckenblockeinrichtung für Eingeleisige Bahnen). Georg Rank. Description of a system designed by Siemens and Halske, with diagrams. 2500 w. Zeitschr d Oest Ing u Arch Verein—April 13, 1900. No. 34136 B.

Improvements.

Improvements on the Ann Arbor Railroad. An account of heavy construction work in the improvement of grades. 700 w. Ry Age—April 27, 1900. No. 33928.

Louisville & Nashville Terminal Improvements, Pensacola, Fla. Illustrates and describes a grain elevator and conveyor, and warehouse. 900 w. Ry & Engng Rev—April 28, 1900. No. 33931.

Recent Improvements in the Sayre Shops, L. V. Ry. Illustrated description of enlargement of shops and connections made, new paint shop, etc. 900 w. Ry & Engng Rev—April 28, 1900. No. 33933.

The Chesapeake & Ohio's Work at Richmond. Brief illustrated account of the new viaduct, new station, and new freight yard. 1800 w. Ry Age—April 27, 1900. No. 33926.

Interlocking.

Low-Pressure Pneumatic Interlocking at Jersey City. Illustrated description of an interlocking plant of the Erie R. R. at Grove st., Jersey City. 1500 w. R R Gaz—May 25, 1900. No. 34415.

Interlocking Protection for Grade Crossings. J. I. Vernon. Read before the Ry. Sig. Club. Illustrates and describes the general method in use at the present time, also a crossing protected by detector bars and signals. 1800 w. Ry & Engng Rev—May 5, 1900. No. 34084.

Shops.

The New Locomotive Repair Shops of the Philadelphia & Reading R. R., at Reading, Pa. Illustrated description, with two-page plate, of this large and complete plant. 3000 w. Eng News—May 24, 1900. No. 34412.

Extensive Locomotive Repair Shops, Philadelphia & Reading Ry. Illustrated description of new shops to be built at Reading, Pa., with a capacity of 100 locomotives. 2300 w. Ry & Engng Rev—May 19, 1900. No. 34353.

Signals.

Manual Controlled and Automatic Signals. Alexander Holley Rudd. Considers the disadvantages of each system, and the advantages that may be gained by combining the two. 4000 w. Eng News—May 10, 1900. No. 34225.

The Controlled Manual and Automatic Block Signaling Systems. C. C. Anthony. A comparison of the degree of safety, facility of moving trains, general satisfaction, first cost, and cost of operation and maintenance. 2600 w. R R Gaz—May 25, 1900. Serial. 1st part. No. 34416.

Automatic Electric Signals at the Paris Exhibition. Illustrates and describes the system worked out by I. A. Timmis. 1200 w. Engng—May 18, 1900. No. 34464 A.

Station.

New Union Station at Grand Rapids, Mich. Illustration with description. 1000 w. Ry & Engng Rev—May 5, 1900. No. 34082.

New Union Station for the Pennsylvania R. R. at Pittsburg, Pa. Brief description, with illustration. 300 w. Eng News—May 10, 1900. No. 34231.

Switchbacks.

The Switchback Lines of the Great Northern and Northern Pacific Railways over the Cascade Range. Illustrated description of switchbacks built to avoid delay in the construction of tunnels, and afterwards superseded by tunnel lines. 2000 w. Eng News—May 3, 1900. No. 33980.

Tracks.

Some Methods of Repairing Tracks in Europe. Editorial on the methods employed, the advantages and objections. 1000 w. Ry & Engng Rev—May 5, 1900. No. 34085.

Vienna Railroad.

The Superstructure of the Vienna Railroad. From a lecture by Hugo Koestler. Detailed description, especially considering the joint construction. 2000 w. R R Gaz—May 4, 1900. No. 33990.

TRAFFIC.

Passengers.

The Growth of Passenger Traffic. Editorial review of statistics of the Interstate Commerce Commission, comparing the growth of the traffic in the United States with foreign countries. 1600 w. R R Gaz—May 11, 1900. No. 34237.

Rates.

Railway Rates for Coal and Coke. George Johnson. Information concerning British rates of transportation. 1200 w. Col Guard—May 4, 1900. No. 34-264 A.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Discussion of the *Union-Elektricitäts Gesellschaft's* Plan for Operating the Berlin *Ringbahn* Electrically (Besprechung über den von der Union-Elektricitäts-Gesellschaft in Berlin Aufgestellten Entwurf für Einführung des Elektrischen Betriebes auf der Berliner Stadt- und Ringbahn). Long discussion before the *Verein Deutscher Maschinen-Ingenieure* on the comparative merits of steam and electrical operation. 12000 w. Glaser's Annalen—April 15, 1900. No. 34119 D.

Bohemia.

The Aussig (Bohemia) Electric Street Railway (Die Aussiger Elektrische Strassenbahn). An illustrated description of this tramway, built by the Union Electric Co., of Berlin. 1200 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—April, 1900. No. 34156 D.

British Tramways.

The Calculation of Distributing Systems of Electric Traction Under British Conditions. H. M. Sayers. States the conditions of working electric tramway systems and their effects, considering these systems in practical use. 7700 w. Brit Inst of Elec Engs—May 3, 1900. No. 34214 D.

Street Railways in British Towns. Robert Donald. Compares municipal systems with company enterprises. 2700 w. Munic Af—March, 1900. No. 34-243 C.

Car Fuses.

Electric Car Fuses; Why They Blow. P. E. Charles. Part first discusses some of the causes. 1600 w. Am Elect'n—June, 1900. Serial. 1st part. No. 34460.

Competitive Tests.

The Tests of Train-Unit Controlling Systems in the Boston Subway. Particulars and views of the apparatus used in the tests of the Boston Elevated R. R. Co. to decide what make of apparatus to use for the equipment of the trains of the new elevated lines. 2500 w. St Ry Jour—May 5, 1900. No. 34020 D.

Dublin.

The Ringsend Power Plant of the Dublin United Tramways Company at Dublin. A. C. Shaw. Brief review of the history of the Dublin United Tramways Co., with illustrated detailed description of the plant and outside equipment. 7500 w. St Ry Jour—May 5, 1900. No. 34017 D.

Dublin Electric Tramways. Illustrated detailed description. 3300 w. Elec Rev—April 20, 1900. Serial. 1st part. No. 33-946 A.

Early Railways.

The First Railway Engineer. An account of William Jessop and his work—1745-1814. 2200 w. Engr, Lond—April 27, 1900. No. 34074 A.

Electric Traction.

The Application of Electric Traction to Existing Railways. Ed. C. de Segundo. Part first refers to the possibility of traveling from New York to Boston by trolley, and the application of electricity to suburban railways. 2000 w. Elec Rev, Lond—May 11, 1900. Serial. 1st part. No. 34363 A.

Electric Traction on the Metropolitan Railway, London. Details as to the permanent way and the equipment. 3300 w. Engr, Lond—May 18, 1900. No. 34471 A.

Electrolysis.

Electrolysis from the Ground Return Current of Street Railways. Albert B. Herrick. Read before the N. Y. Elec. Soc. An explanation of the causes and the damage, the methods of testing to discover the flow and points of departure, and the remedies. Ill. 4000 w. St Ry Jour—May 5, 1900. No. 34024 D.

Electrolysis. E. H. Jenkins. Read at meeting of the Southwestern Assn. Reviews briefly the various systems for overcoming the difficulty. 1000 w. St Ry Rev—May 15 1900. No. 34352 C.

Extension.

Suburban Extension of Union Railroad Company at Providence. Burcham Harding. Describes a new extension following the south shore of Narragansett Bay, and passing through a series of summer resorts. Ill. 700 w. W Elect'n—May 5, 1900. No. 34090.

Glasgow.

Glasgow's Municipal Tramways. Milo Ray Maltbie. Facts and figures gathered in Glasgow and verified, showing great advantages as compared with private operation. 6500 w. Munic Af—March, 1900. No. 34244 C.

Halifax.

Electric Railway System of Halifax, N. S. E. M. Archibald. An illustrated detailed description of the line and its equipment. 2000 w. St Ry Jour—May 5, 1900. No. 34018 D.

Jungfrau.

The Jungfrau Three-Phase Electric Railway. W. H. Molesworth. An illustrated descriptive account of the electrical features of this remarkable engineering work. 3800 w. Elec Wld & Engr—May 12, 1900. No. 34286.

Monorail.

The Single-Rail Suspended Railway Between Barmen, Elberfeld and Vohwinkel (Einschienige Schwebebahn Vohwinkel-Elberfeld-Barmen). Mainly abstracted from a publication of the "Continentale Gesellschaft für Elektrische Unternehmungen" of Nuremberg. A well illustrated description of this interesting railway. 3200 w. Stahl und Eisen—March 15, 1900. No. 34100 D.

Moscow.

Important Changes Proposed in the Tramways of Moscow. Extracts from the report of A. Lineff, a Russian engineer, discussing points to be considered in changing all the system to electric lines and for the construction of new lines. Ill. 1500 w. St Ry Jour—May 5, 1900. No. 34023 D.

Multiple Unit.

A New System of Multiple Unit Control. Report of experiments being made in the subway, in Boston, with the electric-pneumatic system of train control. 1000 w. Elec Rev, N. Y.—May 2, 1900. No. 33967.

Norwich.

Norwich Electric Tramways. An account of the opening of twenty miles of electrically equipped tramways in a city that has not possessed a tramway of any description. Illustrates and describes the line. 1300 w. Elect'n, Lond—May 18, 1900. Serial. 1st part. No. 34475 A.

Operating Tests.

Simple Operating Tests for Electric Railways. Illustrates and describes eleven convenient tests. 3800 w. St Ry Jour—May 5, 1900. No. 34022 D.

Operation.

Operation and Maintenance of Street Railways. H. F. MacGregor. Read at meeting of the Southwestern Assn. Suggestions from the experience of the writer. 1600 w. St Ry Rev—May 15, 1900. No. 34351 C.

Paris.

Recent Railway Work in and About Paris (Neuere Eisenbahnbauten in und um Paris). H. Frahm. A general account of railway terminal and street railway work, well illustrated, in a paper read before the *Verein für Eisenbahnkunde,* Berlin. 7500 w. Glaser's Annalen—May 1, 1900. No. 34121 D.

Paris Exposition.

Transportation Systems of the Paris Exposition. Illustrated detailed description of the three means of travel provided; the moving side-walk, the electric railroad, and the extension of the Railroad of the West. 2500 w. St Ry Jour—May 5, 1900. No. 34021 D.

Stray Currents.

The Influence of Vagrant Currents from Electric Tramways Upon Magnetic Observatories. J. Edler. Abstract translation from *Elektrotechnische Zeitschrift.* An account of the investigations at the Potsdam observatory. Ill. 2000 w. Elect'n, Lond—April 20, 1900. No. 33912 A.

Surface Contact.

The Westinghouse Electro-Magnetic Traction System for Tramways. Illustrated description of this surface-contact system, recently designed. 1500 w. Engr, Lond—April 27, 1900. No. 34075 A.

Surface Contact System at Monaco. Brief illustrated account of the most successful surface contact electric railway in the world. 900 w. St Ry Jour—May 5, 1900. No. 34019 D.

Suspended Road.

See Monorail, above.

THE WORLD IS ITS FIELD.
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INDUSTRIAL DEPRESSIONS AND THE PIG-IRON RESERVE.

By George H. Hull.

THE first requisite for a successful study of this subject is a clear appreciation of the difference between *industrial depressions* and *financial panics.* The former result from an abnormal advance in the price of the great staples of the country, principally those used in the building of houses, railroads, and such other works as are usually classed under the head of permanent improvements. When these staples advance in price as much as 80 to 100 per cent. above their normal market value, a large percentage of the building enterprises of the country are stopped. This throws a vast army of workers out of employment, and causes a heavy decline in the market value of all materials used in these improvements. If this decline in value be equal to the preceding advance, it results in such enormous losses that a financial panic is the almost certain result.

In brief, industrial depressions are the effects of great advances in prices; financial panics are the effects of great falls in prices.

A financial panic is an acute mental malady. Its beginning is sudden, intense, and startling. Its chief element is fright. It paralyzes finances at a single blow, each subsequent step in its course being an alleviation. From its nature, it is short-lived.

Mr. Hull, writing in the *North American Review* in July, 1899, pointed out that the great advance in pig iron, which was then near its maximum, was simply a repetition of what had occurred in 1854, 1864, 1872, 1880, and 1889. And in every one of these cases, the reaction of a severe depression followed swiftly. "It was not disturbed finances nor loss of confidence which turned the tide of prosperity. It was the advance of from one hundred to three hundred per cent. in the price of pig iron. The loss of confidence and disturbed finances came months afterwards and were the effects of the turn of the tide."

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An industrial depression is a stubborn physical malady. Its beginning is so gradual and quiet that it may go on increasing for months unnoticed. From its nature, it is long-lived. It begins when everything is at the height of prosperity. Let me give a local and recent illustration.

In the little community in which I reside, there were twenty-three houses built in 1899, all of which were contracted for before the advance in prices. This kept the workers employed all the year. A large number of residences were planned for 1900, but when the bids for these came in, it was found that a residence which would have cost $100,000 in 1899 would cost $160,000 in 1900. The result has been that as bids have come in the projected buildings have been given up; and, as the houses contracted for at low prices have been completed, the workmen have departed. If this be an isolated instance and these workmen are finding employment elsewhere, then it signifies little. But if this be typical of what has been taking place throughout the country, and they are not finding other employment, then we have already made several months' progress towards industrial depression.

It is estimated that in the United States there were twenty-eight millions of persons engaged in some gainful occupation in 1899. The discharge of five out of each twenty-eight would hardly be noticed in

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The progress of affairs in the year since that was written has made the case still clearer, and in the accompanying article Mr. Hull has so sustained his argument with statistical evidence that it can not fail to be impressive and, we earnestly hope, will be productive of lasting good.

Iron, as Mr. Hull has pointed out, "enters more thoroughly into all business advances and improvements than any other article." It is the very substance of most of the great material creations of modern industry, and the substance of the necessary tools and machinery engaged in producing almost all other wealth. "Its consumption is a correct measure of the wealth and civilization of any people." For "the wealth of a people consists of the accumulation of what their labor has taken from the earth and fashioned into useful and marketable articles and commodities."

"With every able-bodied man employed, wealth is rapidly and steadily accumulated; every man has some surplus for the comforts and material possessions, as well as for the necessities of life; and every man is adding to his property and to the wealth of the nation." This "is the natural condition of an industrious people; it is, in effect, simply the whole people at work, consuming what they need from day to day and accumulating the surplus results of their labor in the form of permanent possessions."

"Whatever restricts the consumption of iron"—the fundamental material *with* which all must work and *upon* which a vast proportion of the total number of producers are working —"whatever restricts the consumption of iron, limits to that extent the growth of the people in wealth and prosperity." And such limitation, Mr. Hull shows most strikingly, has repeatedly been imposed by the enormous advance in the price of iron under every unusual demand—an advance so great that it is prohibitive to enterprise. The cause he finds plainly to be seen in insufficient reserve supply and inelasticity of production. "Every great staple, except iron, is either carried in large quantities or its output can be increased to any desired degree at short notice." Iron, however, is singularly lacking in either means of regulation. "No sane man would build an engine without a governor * * and yet the most important interest of the country is without such a regulator." It is obvious that if the world depended on a three-weeks' reserve of provisions, famine would be a constant menace and a frequent happening. The vast industries dependent on iron are in a similar state of constant danger and of recurring famines, with their attendant exhaustion and painfully slow recovery.

The times emphasize Mr. Hull's grave warnings. It rests largely with the great iron workers of the world, by wisdom and foresight, to avert a disastrous depression following the advance of 1899; as depression followed the seven preceding advances of the last seventy-five years.—THE EDITORS.

any community, large or small, and yet, as soon as this takes place in each community, it amounts to a reduction of three thousand millions of dollars per annum in the buying power of the nation. This is not all. Fewer working hours and reduced wages must be accepted by those still at work. This takes other thousands of millions per annum from the buying power of the nation. No other suggested cause of industrial depressions compares with this in amount, or in its blighting effect upon the industries of a people.

The conditions of industrial depression are, first, discharge of workers, and just in proportion as this takes place the earnings of the people are reduced. This, in turn, cuts down expenditures and lessens demand. As demand falls off, production is cut down and more workers are discharged. Thus the five elements of depression—reduction of employment, of earnings, of expenditures, of demand, and of production form an endless chain, each acting directly upon and diminishing the other, each feeding upon and intensifying the other. The restoration to normal conditions comes only after a lapse of years. It comes finally simply because the natural condition of an industrious people is to be at work. The worker who is thrown out of a place immediately tries to find other employment. He wishes to earn, that he may buy. When all cannot find employment, it is because there is something wrong with the industrial system. When a minimum number are employed, they earn barely enough to supply the daily needs of all, and there is no increase in wealth. When all workers are employed in some gainful occupation, their earnings are so enormous that they not only absorb everything that is produced, but there is an immense surplus which goes largely into permanent improvements, increasing the personal possessions of the individual and the wealth of the nation. This is legitimate prosperity and cannot be overdone. There is a safe limit, and this is reached when all the workers are employed.

The earnings of the twenty-two millions of workers in the United States in 1890 are estimated at thirteen and a half billion dollars, and this does not include incomes from investments. (See Table A). The net products of all industries, including farms, manufactories, mines, quarries, fisheries, etc., are estimated at something over seven billions. No accurate figures are obtainable, but these estimates are on the census of 1890 and are sufficiently accurate to illustrate the fact that there can be no over-production when all workers are employed. So long as natural conditions have unbroken sway, there is no interruption to this vigorous and healthy condition of industries.

PERCENTAGE OF ALL PERSONS ENGAGED IN GAINFUL OCCUPATIONS IN THE UNITED STATES BY CLASSES AND GROUPS.

		1870.	1880.	1890.
GROUP A.	Bankers, brokers, manufacturers, merchants, proprietary farmers, professional pursuits, agents, commercial travelers, book-keepers, clerks, salesmen, etc	34.16	35.96	38.87
GROUP B.	Mechanical trades, clothing makers, metal, wood, leather and textile workers, steam railroad employees, food preparers, etc	20.33	20.72	24.10
GROUP C.	Agricultural laborers, servants, general laborers, miners, quarrymen, draymen, hostlers, street railroad employees, etc	45.51	43.32	37.03
		100.00	100.00	100.00
	Whole number engaged in gainful occupations	12,505,923	17,392,099	22,735,661
	Estimated earnings at the average of $600 per annum	$7,503,553,800	$10,435,259,400	$13,641,396,600
	Gross product of all industries including farms, manufactories, quarries, mines, fisheries, etc	6,843,559,616	7,551,732,385	12,148,380,626
	Amount paid for materials by the manufacturers (supposed to be previously reported)	....	....	5,021 453,326
	Estimated net products of all industries	....	....	$7,126,927,300
	True wealth of the United States	$30,068,518,507	$43,642,000,000	$65,037,091,197

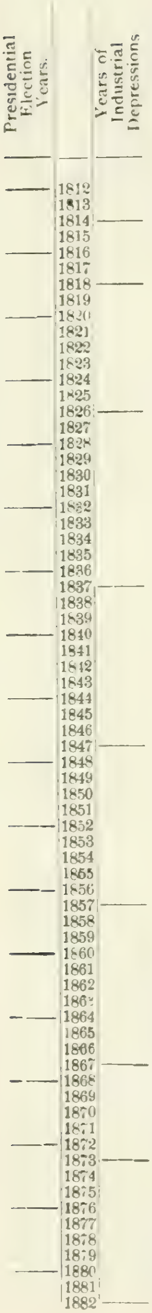
The people consume what they need, from day to day, and pile up the surplus products of their labor in permanent possessions. It is during such periods that the nations of the earth have accumulated their billions of permanent wealth.

To find the cause of these stupendous national calamities, which amount to a reduction of thousands of millions in the earnings of the people and which develop and creep over a whole country almost unnoticed, is the most important question of the present day.

For the solution of this question, the United States Congress appointed three commissions between 1882 and 1886. Like commissions have, in recent years, been appointed by Great Britain, France, Germany, Italy, Canada, and Belgium. Thousands of witnesses testified before these commissions. Their opinions fill volumes, and have been classified under one hundred and eighty different heads. Opinions are the most unreliable of all testimony. They are as varied as the countenances of the people who advance them. The prevailing opinion is often on one side of a question in one country and on directly the opposite side in another. Is it surprising, then, that the substance of all these government reports is that the cause of industrial depressions is still an unsolved mystery?

It is the tendency of the human mind to attribute industrial depressions to financial panics and other surface indications—especially to such causes as are most apparent to each from his individual standpoint. All see the froth and foam which ride on the crest of the wave, but few think of the strong unseen undercurrent which really disturbs the surface. A most striking confirmation of the prevalence of this tendency is found in the evidence of the thousands of witnesses who testified before these government commissions.

The banker cites reasons connected with finance; the laborer cites reasons connected with wages, or with the relations of capital to labor; the merchant cites reasons connected with tariff, transportation, competition, and the like. The clergyman and moralist cite reasons connected with morals and religion. The manufacturer thinks depressions come from over-production, and the politician believes that industrial depressions come from changes of administration, bad laws, etc. The English farmer thinks they come from free admittance to that country of foreign agricultural products. A Dutch committee in 1886 found an important cause in the low price of German vinegar —a German committee, in the great decline in the price of beet-root sugar. None of these touch upon the powerful primary cause. All are surface indications. All are mere opinions. Opinions are not



evidence. They prove nothing, and would not solve this question in another hundred years.

Many people in America have attributed industrial depressions in the past to "Presidential Elections." This can best be analyzed by the accompanying diagram. The intervals between industrial depressions have been four, eight, eleven, ten, ten, ten, six, and nine years, as against four-year intervals between elections. Three times depressions have come one year after elections, twice they have come one year before, and four times they have come half-way between. The only noticeable fact revealed by the diagram is that they have never come on the same year, although there is no logical reason why they should not.

Another alleged cause of industrial depressions is large transfers of money from one country to another. These are simple exchanges of value. Each party voluntarily parts with a value, to secure something considered of more value. Such exchanges help business. They are business—they do not cause depression. The largest transfer of money in modern times was the payment of the war indemnity by France to Germany in 1871 to 1873, and this was without any return of value. If such things brought industrial depression, then France should have been the first to suffer, whereas the depression of 1873 came to Germany several months before it appeared in France. This result was perfectly logical. The 5,500,000,000 francs poured into Germany stimulated her industries to a wonderful degree. The building of factories and other permanent improvements was unprecedented, the price of iron advanced enormously, followed by that of all other building materials. This abnormal advance stopped these improvements, threw large armies of workers out of employment, and industrial depression followed. The war indemnity hastened and intensified the great advance in prices in Germany, hence she was first to experience the logical result.

The large exportation of gold and large importation of goods has often been held responsible for industrial depressions in the United States. If this were ever the cause, there would have been unusual prosperity in Great Britain and the continental countries which reaped the benefit of American extravagance, but such has never been the case. Those countries suffered depressions when the United States did.

The most exact and searching of all sciences is analysis. By its aid we may determine the composition of the heavenly bodies. Let us turn the science of analysis upon this subject.

The United States Commissioner of Labor, in his first annual report of Industrial Depressions, issued in 1886, gives some data, from analysis of the information gathered, which are of great value. First in importance is the conclusion that industrial depressions were most severe in Great Britain, United States, Germany, France, and Belgium, and were not felt to any material extent in other nations. Second, that the degree of severity in these five nations as related to each other was in the order named—that is, most severe in Great Britain, and so on. Third, that industrial depressions were nearly or quite contemporaneous in these five nations. The following paragraph and table is taken from page 290 of said report:

"It has been clearly shown that the depressions of the past in the manufacturing nations of the world have been nearly or quite contemporaneous in their occurrence. Summarized as to dates, the following table is deduced":

TABLE B.

Countries.	Years of Depressions.											
United States..	——	——	1814	1818	1826	——	1837	1847	1857	1867	1873	1882
Great Britain..	1803	1810	1815	1818	1826	1830	1837	1847	1857	1866	1873	1883
France	1804	1810	1813	1818	1826	1830	1837	1847	1856	1866	1873	1882
Belgium	——	——	——	——	——	——	1837	1848	1855	1864	1873	1882
Germany	——	——	——	——	——	——	1837	1847	1855	——	1873	1882

In seeking the cause of industrial depressions, therefore, we may clear the field of a large amount of rubbish by summarily dismissing from the investigation, as untenable, all alleged causes which are purely local in a national sense, such as presidential elections, changes in tariff, demonetization of silver, national banking system, etc.

We must look for the real cause in some condition which was common to the five nations and which did not exist in the other nations, or in something which took place in the five nations contemporaneously and did not take place in the other nations. We must find, also, some cause which placed the five nations in the order they occupied as to relative severity of industrial depressions, and, finally, some cause which grouped little Belgium with the larger nations, Great

Britain, United States, Germany, and France, while Russia, Austria, Italy, and Spain were grouped with the smaller nations.

In the following table, which gives the world's iron production, will be found conditions which meet in every particular the requirements just defined. The record of production in 1882 and 1886 is given, because that was the period covered by the various government investigations which discovered the relative severity of past panics.

TABLE C. PRODUCTION OF IRON IN THE LEADING INDUSTRIAL COUNTRIES.

	1882. Tons.	1886. Tons.
Great Britain	8,586,680	7,009,754
United States	4,623,323	5,683,329
Germany and Luxemburg	3,380,805	3,528,657
France	2,039,067	1,516,574
Belgium	726,946	701,677

On the other hand, a careful search through the 800 pages of Mulhall's Dictionary of Statistics fails to reveal any matter connected with Finance, Agriculture, Manufacture, Earnings, Expenditures, or Trade, which answers these requirements. There is, in fact, no matter aside from iron production which even places the five countries in one group, to say nothing of placing them in the order they occupy as to severity of industrial depressions.

Before iron became of preponderating importance to the industries of nations, there were no industrial depressions except those born of causes apparent at the time, such as pestilence, famine, and war. The condition of industries in the United States up to 1814 was one of uninterrupted prosperity. France and Great Britain, which then furnished the world's iron supply, experienced two seasons of industrial depression during this period. The United States was the next country to produce sufficient iron to give it importance in the economics of the nation. Later on Germany and Belgium became large producers, and just in this order they commenced to experience industrial depressions. Table B, page 647, reflects these facts.

Iron is acknowledged to be the foundation on which the modern industrial system rests. If that system is disturbed, it is most natural to look to the foundation for the cause of the disturbance. If one would appreciate how thoroughly the entire industrial system depends upon iron, let him imagine what the world would be to-day without it —what it would be if we depended upon wood, stone, copper, and tin for our implements of agriculture, tools, machinery, vehicles of trans-

LOWEST AND HIGHEST PRICES OF SCOTCH PIG IRON IN NEW YORK FROM 1825 TO 1882, FROM THE AMERICAN ALMANAC.

EDITED BY AINSWORTH R SPOFFORD, LIBRARIAN OF CONGRESS.

			Lowest.	Highest.	Year.	
Low,	High,		**35.**	**75.**	1825	114 per cent. advance.
		Depression.	50.	70.	**1826**	
			50.	55.	1827	
			50.	55.	1828	
			40.	55.	1829	
			40.	50.	1830	
			40.	47.50	1831	
			40.	47.50	1832	
			37 50	47.50	1833	
Low,			**37.50**	48.	1834	
			38.	42.50	1835	
	High,		38.	**62.50**	1836	
		Depression.	40.	**70.**	**1837**	86 per cent. advance.
			37.50	55.	1838	
			37.50	45.	1839	
			32.50	40.	1840	
			32.	37.50	1841	
			23.50	35.	1842	
Low,			**22.50**	32.	1843	
			30.	35.	1844	
	High,		30.	**52 50**	1845	133 per cent. advance.
			35.	42.50	1846	
		Depression.	30.	42.50	**1847**	
			25.	37.50	1848	
			22.50	27.50	1849	
			21.	24.	1850	
			19.	25.	1851	
Low,			**19.**	31.	1852	
			28.50	38.	1853	
	High,		32.	**42.50**	1854	123 per cent. advance.
			26.50	37.	1855	
			29.	37.	1856	
		Depression.	28.	37.50	**1857**	
			22.	27.	1858	
			22.	31.50	1859	
			20.50	27.	1860	
Low,			**20.**	24.50	1861	
			21.	33.	1862	
			32.50	45.	1863	
	High,		43.	**80.**	1864	300 per cent. advance.
			40.	55.	1865	(Depreciated currency.)
			42.	55.	1866	
		Depression.	38.	49.	**1867**	
			35.	45.75	1868	
			34.50	45.	1869	
			31.	37.	1870	
Low,			**30.**	39.	1871	
	High,		33.50	**61.**	1872	103 per cent. advance.
		Depression.	37.	52.	**1873**	
			33.	45.	1874	
			29.	41.	1875	
			27.50	34.	1876	
			25.	28.	1877	
			21.50	26.50	1878	
Low,			**19.**	30.50	1879	
	High,		21.	**35.**	1880	84 per cent. advance.
			22.	26.	1881	
		Depression.	23.	26.50	**1882**	

portation on land and sea, the vast network of rails on the surface, and the pipes which carry water, gas, etc., under the surface. What proportion of these could have existed without it? It matters little what its price is, provided that price is stable. The industries of a nation depend upon the actions of an aggregation of individuals. When the individual considers an expenditure for a permanent improvement, and finds that improvement will cost 50 per cent. to 100 per cent. more than it would have done a year before, or is likely to do a year later, he acts, and that action is almost invariably a postponement of that improvement.

This, in a nutshell, is the reason that industrial depressions follow an abnormal advance.

Iron is a powerful instrument for good when under control, and just as powerful an instrument for harm when not under control. It is not under control when it advances in price 80 to 100 per cent. above its normal cost.

To illustrate how inevitably these depressions follow each abnormal advance in iron, I give Table D, page 649, in which the low prices, the high prices, and the crises of depressions which followed each advance are given in heavy-faced type. A careful review of the authoritative publications upon the subject reveals the fact that the conditions of each of these seven periods of abnormal advances in iron were identical in their train of events, and the advance of 1899 is no exception to the rule. First, there was a revival of industries, such as occurred in 1897 and 1898, during which the employment of workers was gradually, but very greatly, increased. This brought about a corresponding increase of earnings, amounting to thousands of millions. The earnings being largely in excess of the products, these surplus earnings were used, first, in a more generous indulgence in the comforts and luxuries of life, then in investments in existing wealth, particularly that represented by bonds, stocks, and certificates, because these are more easily transferred. This advanced securities to something like their real value. Later, investments were made in permanent improvements, such as houses, factories, railways, etc. This last brought about a sudden and enormous advance in the price of pig iron, because the conditions surrounding its production made it impossible to increase the supply rapidly enough to meet the demand. All the other staples could easily have been provided in quantities sufficient to have met the demand without abnormal advances in their price, because increased supplies are quickly available. Thus, of lumber, two or three years' stock is always carried, and brick, stone and coal can always be adequately and quickly supplied by simply increasing the workers in brick yards, stone quarries, and coal mines. But of iron we have carried for the last ten years less than twenty-three days' production, and it takes a year to build a furnace. Consequently, in each period of revival in the industries of the world, iron consumers became alarmed through fear that there would not be enough to supply all demands; each buyer made an effort to contract for sufficient to supply his needs, and this being impossible to accomplish, prices advanced rapidly until they reached 80 to 100 per cent. above cost. These advances in iron invariably occurred before there was any material advance in the prices of the other staples. If the other staples were subject to the same conditions which control iron, they would have advanced when it did. When the advances in the other staples came, it was not from necessity, but simply because the advance in iron gave the holders of other staples excuse and opportunity. If the advance in iron had not exceeded 10 or 15 per cent., the advance in the other staples could not have been greater, and prosperity would not have been checked. In every period of depression, the check to all constructive enterprises came with the completion of works contracted for at normal figures. Iron was first in each period to show short supply, and the difficulty of procuring anything made of iron and steel existed throughout the entire period of the boom. When that difficulty ceased, the boom ceased and the conditions of industrial depression began their silent and blighting work. Not from lack of money or confidence, but in the very height of plenty and business activity.

Having analyzed the course of events which followed the seven abnormal advances in the price of iron within the fifty-eight years covered by Table D, let us analyze the period of sixteen years which followed, during which time there was no advance which was general or of like magnitude. For this purpose we will use the records of iron prices in Glasgow, Philadelphia, and Cincinnati, as Scotch pig iron was not imported in sufficient quantity to reflect world-wide conditions during this period. Table E, presenting these records in comprehensive form, appears on the following page.

As will be observed, there was no great advance during this sixteen-year period, and when an advance occurred in one place it was only partially responded to in the others. There was no general advance which stopped the great building enterprises, and consequently no long-lived industrial depression. There was a financial panic in 1890, induced by the Baring troubles. It had effect upon the industries in 1891, but they were unusually prosperous again in 1892. There was a very severe financial panic in the United States in 1893. This paralyzed everything for a time, but the industries were more prosperous than ever in 1895. There was a severe money stringency during the presidential campaign of 1896, but it was not rated as a financial panic, and business quickly revived early in 1897. This period of sixteen years illustrates the fact that financial panics are short-lived.

TABLE E. COMPARATIVE IRON PRICES FOR SIXTEEN YEARS.

	Glasgow, Scotland.		Philadelphia, U. S. A.		Cincinnati, U. S. A.	
Year.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.
1883	44/2	48/3	21.	25.	18.	22.
1884	41/3	43/5	18.50	20.50	15.50	19.
1885	41/1	42/10	17.75	18.25	15.50	20.
1886	38/4	43/3	18.25	20.	17.	23.
1887	39/5	46/4	20.50	21.50	16.	21.50
1888	37/10	42/	18.	21.	14.75	19.
1889	41/3	61/5	17.	19.25	15.	20.50
1890	44/7	61/1	18.	19.90	14.50	18.50
1891	43/8	51/2	17.50	17.75	13.25	17.50
1892	40/10	45/11	15.	17.50	13.25	17.
1893	40/9	45/3	13.75	15.	12.25	15.50
1894	41/9	43/8	12.50	13.37	11.	14.25
1895	41/4	47/10	12.	14.50	11.75	16.40
1896	45/10	48/7	12.50	13.56	12.	15.
1897	44/2	48/4	11.75	12.75	9.25	11.
1898	45/10	49/7	11.25	12.	9.50	10.50

When panics result from and occur during seasons of great industrial depression, they get the reputation of being long-lived. But it is in reality the effect of the industrial depression which is long-lived. Panic effects pass away long before the recovery from the effects of industrial depressions. The industrial depressions of 1837 and 1857, both of which were attended by financial panics, continued no longer than the industrial depression of 1874, which was not attended by financial panic.

These violent and wholly unnecessary fluctuations in prices, which we call booms, disturb all business, but their greatest injury is to the pig-iron producers. The building and reviving of furnaces is unduly stimulated. This results in disaster to many, and undue lowering of prices to all, on the reaction. The financially-strong producers must accept prices which the weaker ones are forced to make; thus prices are carried abnormally low. Nearly the entire period covered by booms is occupied by the industrial world as a whole in filling low-priced contracts. By the advance in prices of labor and raw materials, many lose on contracts which, but for the advance, would have paid a profit. The boom is attended by high wages and frequent strikes for higher. The decline is attended by constant strikes to resist wage reductions which manufacturers must make to save themselves. Workers lose more by idle months than they gain by the temporarily advanced wages. The business world as a whole gets no benefit from booms. Stripped of all of its disguises and illusions, a boom is simply a cruel and disastrous blow to the industrial world.

The increase in the buying power of the people, which comes from increased employment, is natural and beneficial. Such earnings come with regularity as a reward to the worker. They are substantial, and as a rule are expended in a prudent manner. They are absorbed naturally by all branches of business and are wholly beneficial. The increase in earnings which comes suddenly from abnormal advances is temporary and unnatural. It over-stimulates business and speculation; it raises values, particularly those most easily transferred, such as stocks and bonds, to abnormal figures. It is an illusory profit, and encourages unwarranted expenditures. When the inevitable decline to normal prices takes place, it brings disaster.

No reformation is needed in the business connected with producing and marketing the necessities of life. The government commissions have discovered that trade in food and clothing is attended with comparative uniformity, in magnitude and in profits, in bad times as well as in good.

All industries may be divided into two classes—production of daily necessities and production of permanent wealth. It is the last which suffers from abnormally high prices. We can stop building, but we cannot stop eating. When the price of iron is under proper control, the industries connected with building will be as uniformly profitable as trade in food and clothing.

The only possible way to bring iron under proper control is to accumulate, in each of the iron-producing countries of the world, a stock of pig iron equal to several months' production. It will not suffice to do this in one country only. The demand from the others would carry its price up with theirs. Each country must accumulate an adequate reserve stock of its own. If this be done during the next few years, there will be no more periods of boom and no more periods of industrial depression, except such short temporary interruptions as may come from financial panics; in time, they, too, may be understood and prevented.

If the manufacturers of building materials would, at this juncture, voluntarily and promptly, put down prices to within 10 per cent. of normal figures, which is as low, also, as they should ever have gone, even in periods of most marked depression, it would revive a large number of the building enterprises which are now postponed or abandoned, and a prolonged industrial depression might even at this late date be averted. If, on the other hand, prices are held up, until sales are forced by the accumulation of excessive stocks made at high cost, then heavy losses and failures will occur, confidence will be lost, and no amount of reduction will revive the postponed enterprises, until the iron-producing nations have passed through just such another industrial depression as has heretofore followed each abnormal advance in the price of iron.

There is a wonderful future for the iron business the day these violent fluctuations in its price are ended. The annual consumption of iron in the United States is growing with a cumulative force. Fifty years ago it was 100 pounds per capita, two years ago 300 pounds, and last year 400 pounds per capita. Within twenty-five years it should be 1,000 pounds. Not one-twentieth of the inhabitants of the earth are comfortably housed, fed, and clothed. The world is not finished. There are whole continents to be developed. There is plenty for all to do. Let everyone work who will. It requires a certain number of workers to produce the daily necessities of the people. Every additional producer put to work adds to wealth. When the price of iron is under control, the manufacturing nations will make such regular and uninterrupted progress as will astonish the world.

Iron is the most valuable gift nature ever bestowed upon a nation. The owners of the great iron properties have an opportunity of untold wealth within their grasp. They may, by wise action, change a business which in the past has been attended by one or two years of profit, followed by seven or eight years of loss, to a business of uninterrupted profit.

The act which puts an end to seasons of industrial depression will inaugurate an era of unexampled prosperity to the iron-producing nations of the world.

CHINA IN REGENERATION: AN EPOCH AND AN OPPORTUNITY.

By John Foord.

IN a mad carnival of blood and rapine, a new China has been born. The change might have come otherwise—could have come, one is tempted to believe, had the crime of September, 1898, not been accomplished with the tacit consent or active sympathy of the representatives of the Great Powers of the west. An awful price has been paid for the trustful optimism of the legations, and the policy of creating trouble by seeking to avoid it, which has been so much in favour in quarters to which the Chinese reform partly looked for encouragement and support. The story is all the more ghastly because of the warnings, loud and frequent, which preceded the final catastrophe, but it is not the first time that those who lived nearest the crater of a volcano were least regardful of the premonitory rumblings that precede a great eruption. All the world has seen and shuddered at the dire sequel of the policy of opportunism in the foreign dealings with the corrupt, unscrupulous, and woefully ignorant Government at Peking. But the awakening has been too horrible to permit of a lapse into indifference again. Let diplomatic precedent be strained as it may, order must come out of this chaos of savage passions and mad ambitions, and a regenerated China will be the result. Punishment, just and exemplary, must have its course, which should, however, be all the shorter because those primarily responsible for all the nameless atrocities of the reign of terror are high in place and power. But reconstruction must go hand-in-hand with judgment, if one-fourth of the human race is to be saved from falling a prey to the contagion of their own lawless passions, manifested on a scale unheard of in the history of mankind.

In an article on recent industrial progress in China, by Mr. J. S. Fearon, and Mr. E. P. Allen, published in THE ENGINEERING MAGAZINE for November, 1898, the statement was made, that "It is to the interest of western nations that the central authority in China shall be upheld, and particularly is it to the interest of the United States." The world has just seen the collapse of that Government, but it remains true that, among all the nations of the world, none has a more direct interest in the restoration of its integrity than the United States. The American Government recently went out of its way to obtain assurances from all the great powers of Europe that the principle of equality of commercial opportunity would be respected, no matter what extension might be secured of their so-called spheres of influence in China. But there are other ways of interfering with trade than by hostile tariffs or discriminating duties, and, in the event of the dismemberment of China, we should have to deal with spheres of sovereignty rather than spheres of influence, and equality of treatment for "foreign merchants" would be quite compatible with totally different treatment for the merchants belonging to the nation which happened to be in possession. As Messrs. Fearon and Allen put the case: "The destruction of the general Government at Peking would mean a breaking up of the Empire along the lines of provincial cleavage, and that would entail a serious retardation of all progressive measures of Imperial dimensions now projected. Fancy the difficulty of constructing, and the greater difficulty of operating, a railway from Peking to Canton, across half a dozen frontiers, with innumerable taxes to pay and endless official interference to oppose. Such a condition would not be permitted to remain, and the destruction of the Peking Government would therefore be the signal for a final and irrevocable partition of China, in which the United States would scarcely have a part."

A tremendous impetus must be given to all forms of business enterprise in China by the restoration of law and order on a more secure basis than they have recently occupied. The enemies of reform were also, of necessity, the enemies of the foreigner, and there could be no safe compromise between the policy of reaction and that of progress. The process of going backward inevitably resulted in the liberation of the forces of disorder, of which the world has just witnessed the tragic results. The resumption of the forward movement, which was so violently interrupted two years ago, will carry with it the guarantee of a more prosperous, more contented, and better-governed China. The cataclysm which has rendered impossible the perpetuation of the power of the Empress Dowager and her knot of reactionary advisers has opened up China to the world no less surely than the disappearance of the Shogunate marked the beginning of the new era in Japan.

If the prospective trade of the United States with China is to be measured by the progress of the last few years, it is likely to assume a fairly impressive total. Its value in 1892, exports and imports, was

16,846,555 Haikwan taels; in 1899 it was 43,074,460 Haikwan taels. The trade of no other commercial power, save Japan, shows an equal ratio of increase. These figures exclude the trade of the United States with Hong Kong, whose dimensions are only partially indicated in the returns of the Bureau of Statistics of the United States Treasury, since a considerable portion of it went or came by way of England. The direct trade of the United States with Hong Kong, which was valued at $5,657,472 for the fiscal year 1892, was $10,211,799 in 1899. As the American consul at Che Foo has pointed out, in 1897, the value of American sales to China exceeded those of all continental Europe, including all the Russias (European and Asiatic) by $320,281; in 1898, this excess had increased to $4,171,934, and in 1899, to $6,191,836.

But the magnitude of the commercial opportunity in China is not to be measured by any rate of growth already established. Foreign trade has merely scratched the surface of the possibilities of China, and, given the slightest increase of the purchasing power of 350,000,000 of people, the results would assume stupenduous magnitude. This increase may come in several ways. The vast latent resources of the Empire have been indicated in previous articles in this Magazine, and are sometimes referred to as involving a most formidable source of competition with the industrial activity of the west. As all the experience of mankind has shown that increase of wealth means increase of wants, it should hardly be necessary to combat the fallacy that the development of China would not benefit all the rest of the world. To equip China with the appliances of modern civilisation is not a task to be finished in one generation or two, and, in the course of doing it, a fourth of the human race will be raised to a new standard of living, and things which are now the luxuries of the well-to-do will become, as they have done elsewhere, the necessities of the day labourer in the near future.

With the pacification of China must come a reform of its whole economic and administrative system. There can be no guarantee for the maintenance of order while corruption runs riot in the palace, and no security against the recurrence of popular outbreaks if the people are to be taxed to support a thieving horde of useless officials. Great as the undertaking of putting new life into the Government of China undoubtedly is, there are native Chinamen quite equal to it, if those who direct affairs from Peking, or some new capital, do not demand corruption as the first requisite of public service. We must assume it to be possible for a combination of the powers vitally interested in the preservation of China to establish, support, and guide a central government which would not be foredoomed to become a prey to its own rottenness. A sound and progressive system of rule could have been begun two years ago, and all that has happened since has only served to bring out in stronger relief the vital necessity of the reforms initiated by the Emperor, and not at all to lessen their practicability. One of the first achievements of such a government as is urgently demanded by the necessities of the situation, because one of the most powerful aids to the redemption of China, would be the carrying out of a comprehensive scheme of railway construction. That has already had a definite start and the results have been most encouraging. Its general outlines may be assumed to be indicated by the concessions applied for by the various financial syndicates and more or less securely guaranteed. In its annual report, recently issued, the China Association of Great Britain gives the following summary of railways actually built, in course of construction, or projected, throughout the Empire:

(A) Railways completed and working:

1. The Imperial Chinese Northern Railway from Peking to Tientsin and Shanhaikwan (with extension to Sinminting and Newchwang nearly completed).

2. Peking to Paoting-fu (built by the Chinese Government, but incorporated as part of the Lu-Han line).

3. Shanghai to Woosung (built by the Chinese Government, but to be incorporated as part of the Shanghai-Soochow system).

(B) Railways in progress or projected, for which concessions have been granted to:

1. Russia, for the so-called Chinese Eastern Railways in Manchuria.

2. The Russo-Chinese Bank for a line from Cheng-ting (a station on the Lu-Han line in Pechili) to Taiyuen, the capital of Shansi.

3. A Franco-Belgian Syndicate for a line (known as the Lu-Han) from Peking to Hankow.

4. An American Syndicate (which has agreed, since, to share its interests with the British and Chinese Corporation) for a line from Hankow to Canton.

5. Germany, for a railway triangle—from Kiaochow to Tsinan, Kiaochow to Yi-hien, and from Tsinan to Yi-hien in Shantung.

6. An Anglo-German Syndicate for a line from Tientsin to the Yangtse opposite Chinkiang.

7. The British and Chinese Corporation for lines:

(a) from Shanghai to Soochow and Nanking.

(b) from Shanghai to Hangchow, with possible extension to Ningpo.

(c) from Pukou (opposite Nanking) to Hsinyang, a station on the Lu-Han railway, in Honan.

(d) from Canton to Kowloong.

8. The Peking Syndicate (British) for lines:

(a) from Taokow on the Wei River to Weihwei and Tsechow.

(b) from Tsechow via Honan-fu to Siang-yang on the Han.

9. France, for lines from:

(a) Pakhoi to a point not yet determined on the bank of the West River (presumably Nanning).

(b) Lungchow (on the frontier of Tongking) to Nanning or Pésé.

(c) from the frontier of Tongking (presumably Laokai) to Yunnan-fu.

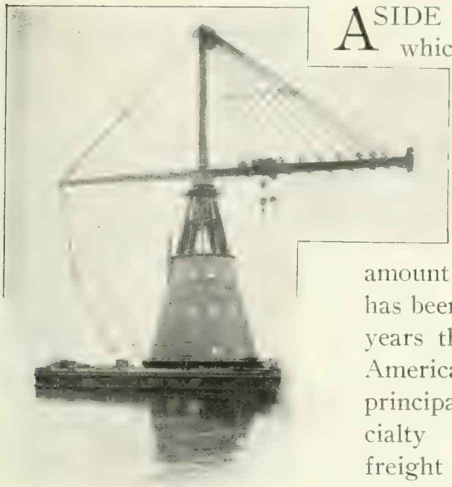
(d) Kwangchow Bay, across the neck of the peninsula, to Om-pu.

It will be observed that American interests cut no great figure in all this projected construction, being confined to the Hankow-Canton project. But, for all essential purposes, American and British interests in China are identical, no less in the matter of railroad construction and equipment than in the general field of commerce. Neither British nor American manufacturers want anything more in China than a fair field and no favour, and the promoters of no enterprise appealing to British or American capital are bound by any conditions as to the market from which they are to draw their materials. It is otherwise with the Belgian, French, and German syndicates, all of which agree to buy nothing from foreign sources unless at the call of absolute necessity. Russia's disposition to draw part of her railway material from the United States has always been more or less dependent on her success in borrowing money there to pay for it. In short, tested by their actual practice, rather than by their promises, only Great Britain, the United States, and Japan can be confidently reckoned on to stand for the maintenance of equality of commercial opportunity throughout the Chinese Empire, and consequently to stand for the preservation of its integrity. Of the three, the influence of the United States is likely to be the most potential in saving China from dismemberment, since not the faintest desire is felt in that country to possess a yard of Chinese soil by "lease" or otherwise. The absolutely disinterested position which the United States Government occupies in relation to the greatest of all the problems now before the civilised world almost necessarily renders the side which it may take in the settlement of China's future the most powerful one. It has only to speak with sufficient decision and show its readiness to act with sufficient resolution to have its decision respected.

Every productive interest in the United States has an obvious stake in the preservation of the Chinese market, alike for the present and the future. The pinch of interrupted business in North China has already been felt by cotton mills both north and south, and the stoppage of this outlet for the one important branch of textile exports would entail serious losses on the people who have invested millions in southern mills on the faith of its continuance and development. The bulk of this part of American trade with China happens to be done through the northern treaty ports of Tientsin, Chefoo and Newchwang, and the wearers of American drills, jeans, and sheetings are to be found in that part of the Empire which would naturally be absorbed by Russia and Germany in the event of the policy of dismemberment proving the stronger. In such an event, it would be a slender consolation for the people of the United States to be assured that they would still have access to the Yangste valley as a field for trade, because of the magnanimous practice of Great Britain in allowing all the world to come in, without discrimination, wherever her authority is supreme. Only one-tenth of American trade with China is done in the provinces contiguous to the Yangtse, and however great may be the possibilities of that region for American manufactured products, the dictates of ordinary business prudence manifestly demand that all China should be kept open for them, from Yunnan to Manchuria. The Government of the United States missed the chance in the closing weeks of 1897, to arrest the steps taken at that time toward the partition of China; it cannot afford to repeat the easy indifference then displayed to events which were supposed to be none of its concern. Events now in progress more nearly concern the interests of the American Republic than those of any other country, because its position demands that it should be the great power of the Pacific Ocean, and because the vastness and variety of its productive resources clearly designated it as destined to become the greatest manufacturing and trading nation in the world.

THE SHIP-BUILDING YARDS OF THE UNITED STATES.

By Waldon Fawcett.

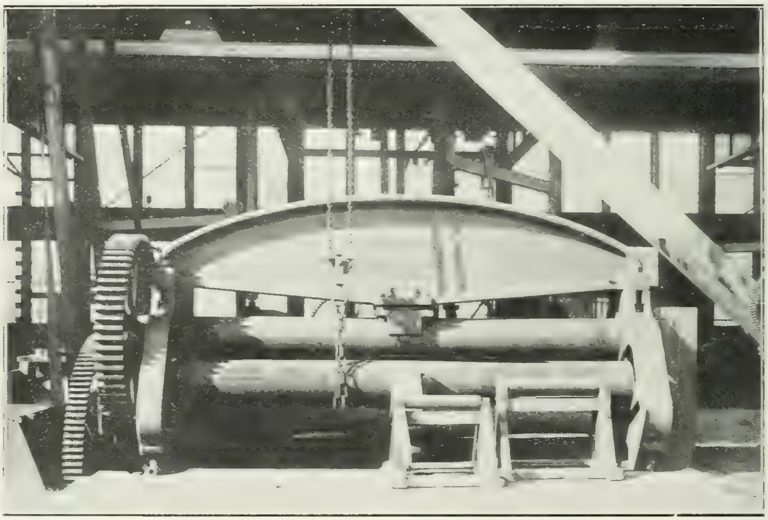


ASIDE from the very largest yards, which were treated in my preceding article, one of the most interesting plants in America is that of the Harlan & Hollingsworth Co., at Wilmington, Del. It is a plant which turns out an immense amount of tonnage and, although there has been built here within the past two years the largest torpedo boat in the American navy, attention is devoted principally to mercantile craft. A specialty is made of passenger and freight steamers for coastwise service. The Harlan & Hollingsworth Company's yard occupies 76 acres and comprises more than fifty iron, brick, and wooden buildings. Motive power for each department is supplied from its own engine room, there being in the yard 15 engines with a collective horse power of 1,500. The water frontage on both banks of the Christiana River aggregates 3,000 feet and twelve berths are provided. The machine shop is fitted with all the latest improvements in metal-working machinery, including one of the largest boring, milling, and drilling machines ever built in the United States. In the blacksmith shop are five steam hammers, ranging from 500 to 2,000 pounds drop, and a press machine and punch capable of punching a 6-inch hole through inch plate. This is operated by a special upright fly-wheel engine and is connected by cog gearing.

The equipment of the boiler shop includes an immense hydraulic riveting plant, having a duplex hydraulic supply pump with 12 by 10 inch steam cylinder, a 7 inch diameter by 14 foot stroke hydraulic ram with ample accumulator, and a patent fixed cast-steel "Atlas" or flush-top riveter with automatic plate-closing attachment, having a gap of

10½ feet in the clear and operated under a pressure of 1,500 pounds per square inch. The last mentioned machine exerts 100 tons' pressure upon the rivet and plate. In addition to all these, there are four traveling cranes of large capacity. A novel feature of the Harlan & Hollingsworth plant is the upholstering department, where not only is the construction of all furniture for ships carried on, but all the linen for vessels is made and marked as well.

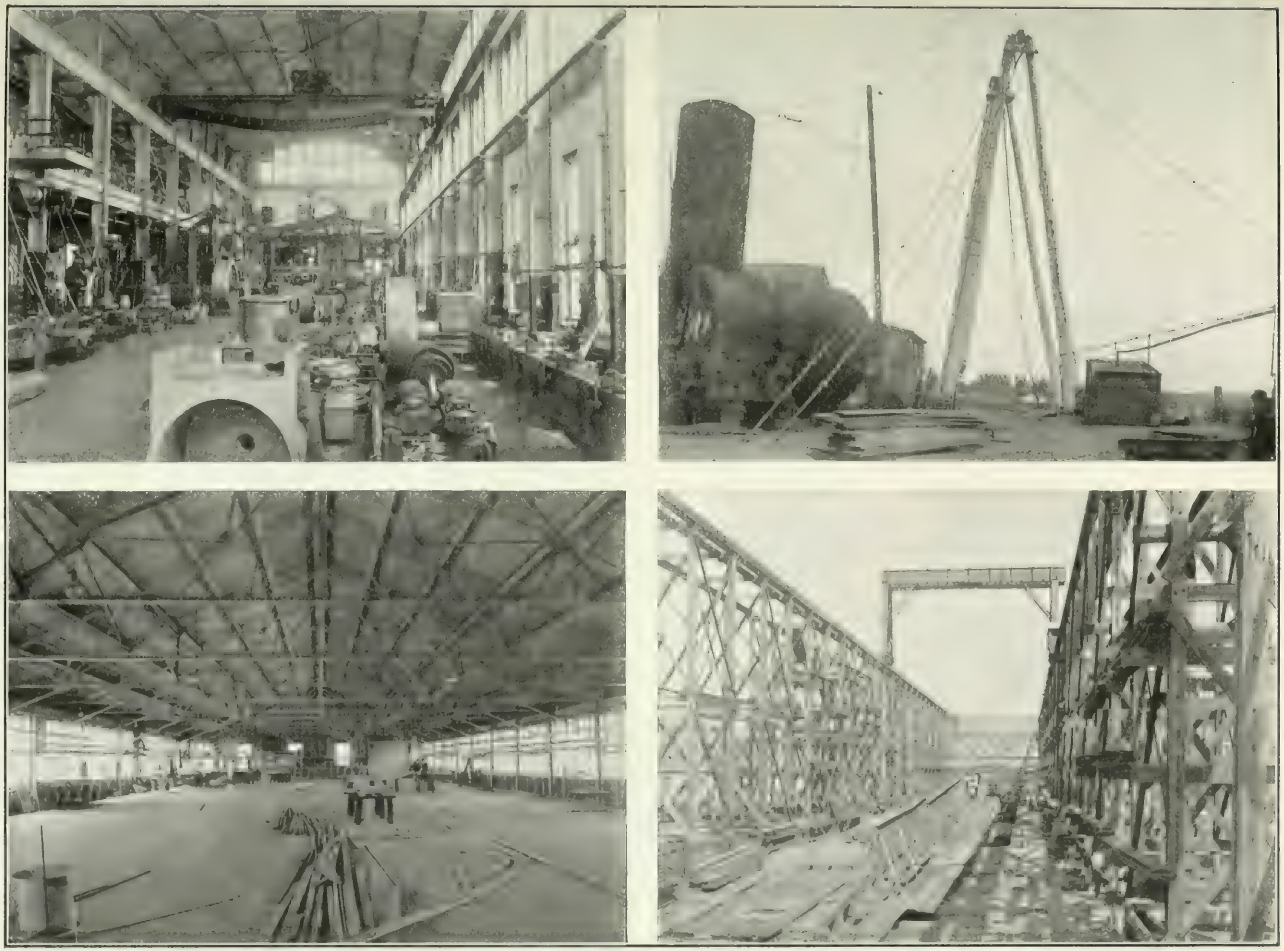
For the expeditious handling of material throughout the plant, the various shops are connected by a net-work of tracks and there is in service an electric locomotive capable of hauling a small train, the motor of which is supplied with power by its own engine and dynamo.



ROLLS, HARLAN & HOLLINGSWORTH COMPANY'S MACHINE SHOP, WILMINGTON, DEL.

There are five erecting shops. All the electrical apparatus required on the vessels constructed by the company is manufactured on the premises, and there is a carving room where 30 first-class carvers are regularly employed. Another distinctive feature is found in the plate racks. The plates stand on edges between upright cast-iron toothed post frames, set in a large circle. They are lifted into or out of these racks by means of a clamp device which automatically adjusts its grip in proportion to the weight of the sheet to be handled, and which is swung from a central derrick. Thus but one operation is required for the transfer of the plates from the railroad car to a place in the racks.

The set of masting sheers at this Wilmington yard is of exceptional interest, by reason of the fact that the greatest possible strength of construction is embodied. The claim is made that this sheers is the



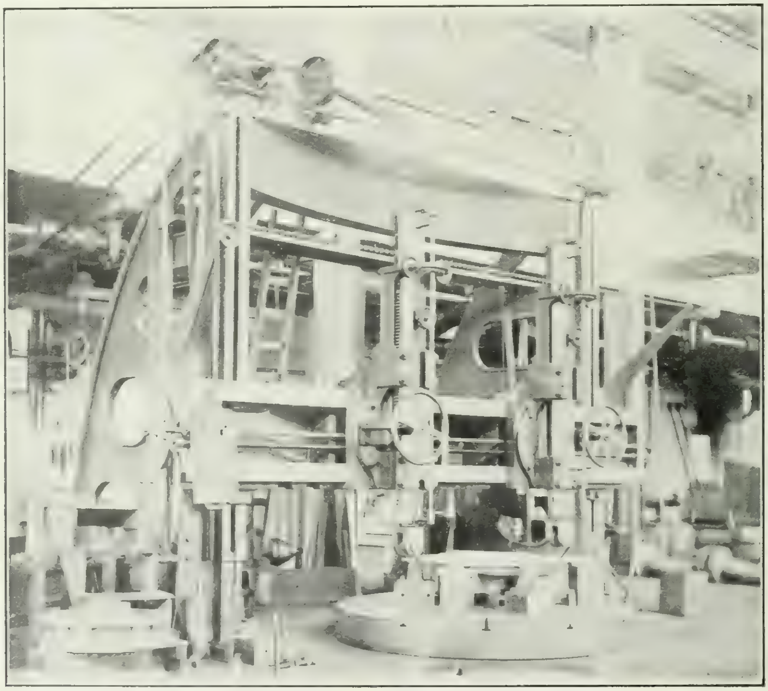
The machine shop.
The mould loft.

The masting sheers.
Gantry crane.

VIEWS IN THE YARD OF THE HARLAN & HOLLINGSWORTH COMPANY, WILMINGTON, DELAWARE.

only one in the United States capable of lifting 150 tons' dead weight without exceeding the elastic limit, the extreme capacity of the sheers being 356 tons' dead weight. The height of the stationary legs of the sheers is 84 feet, and the "reach" from the perpendicular is 50 feet, while that of the leaning pair of legs is 35 feet beyond the wharf front.

In planning a ship, the Harlan & Hollingsworth company follow a method of procedure somewhat different from that observed in many British and European yards. The estimated tables of displacement are prepared first, and a block is then shaped into the approximate form and size required to caliper to the required displacement, after which the actual tonnage at the desired draught is determined by a detailed examination of the weights to be created. The approximate model, embodying as it does all the principles of stability, entrance, run, flare, sheer, and body balance desired, is smoothed and "faired" down to the exact point of displacement aimed at. After the approval of the model, the course in the mold loft becomes the normal one in general use, save in two minor particulars, *i. e.*, an improved scribing device is employed in connection with drawing in the frames and other



LARGE BORING MILL, HARLAN & HOLLINGSWORTH MACHINE SHOP.

sectional curves upon the floor, and only wooden molds or battens are used as patterns in bending the frames and other angles.

Another feature of ship-yard work in which the Harlan & Hollingsworth practice differs from that at some other yards is in getting a ship overboard. The wedges are, at a signal, driven in and the ship thus raised sufficiently to relieve the strain upon the blocks. When these are split from end to end of the vessel the whole weight rests upon the sliding or launching ways, which in turn lie upon the permanent or ground ways, and the ship would, of course, break away were it not for a thick cross-bracing of tough timber at her bow. The launching cradle is lashed together under the keel by strong rope "toggles" from side to side at intervals toward the bow. The splitting of the blocks is followed by the knocking down, one by one, of the shore braces. Finally the cross-braces which secure the two sets of ways are sawed asunder. A 60-ton hydraulic jack is placed under the forefoot of the stem to give the vessel an impetus in case of emergency. The checking of the ship when afloat is done exclusively by snubbing lines. The British practice of using buried anchors is not employed at all. The time consumed between the signal for wedging and actual start varies, but may be given as from 15 to 20 minutes on the average.

THE BATH IRON WORKS, BATH, MAINE.
Showing the ship-building shed.

The gantry crane at the Harlan & Hollingsworth yard has a capacity of 7 tons and is operated by electricity. It travels over the entire length of one ways and covers that portion of the yard used for the fitting and riveting of frames and bulkheads. The store system is excellent. The books are kept after the fashion of a regular retail hardware and ship-chandlery store. Sales are registered, and must be based upon authenticated requisitions from foremen. Daily returns are made to the main office.

In capacity and equipment and other general characteristics, two of the ship-yards on the Delaware River might be classed with the Harlan & Hollingsworth plant. One of these is the Roach ship-yard at Chester, Pa., where were constructed some of the first iron and steel vessels built in the United States, and the other is the plant of the Neafie & Levy Ship & Engine-Building Co. at Philadelphia. Neither plant is, of course, of recent establishment, but both have been thoroughly modernized by enlargements and the introduction of new machinery, together with a complete equipment of pneumatic appliances. Both yards have given considerable attention during recent years to the construction of sea-going steel yachts of the highest class.

IN THE NEW MACHINE SHOP OF THE BATH IRON WORKS, BATH, MAINE.

At Bath, Me., and neighboring ports on the north Atlantic coast are to be found a group of ship-yards which are in many respects very

THE YARD OF THE NEW ENGLAND COMPANY, BATH, MAINE.

interesting. Bath was once known as the home of the clipper ship, but with the decadence of wooden-ship-building the aggregate of new tonnage turned out dropped off very rapidly. Of late years, however, the steel-ship-building industry has gained a foothold at the Maine port and has thrived surprisingly, while the creation of a new demand for wooden bottoms for the coastwise coal trade and other lines of traffic has resulted in the reopening of a number of the yards. During

THE YARDS OF KELLY, SPEAR & CO., BATH, MAINE.

YARDS OF THE NEW ENGLAND SHIP-BUILDING COMPANY, BATH, MAINE.

the calendar year 1899—the last full twelve months for which statistics are available—the seven yards at Bath turned out two ships, two schooners, three steamers, twenty-seven barges, and two sloops—a total of thirty-six vessels of 39,120 gross tons burden.

Among the Bath yards first place must be accorded to the Bath Iron Works, which engages in the construction of steel vessels exclusively. The yard gives employment to more than 1,000 men and the weekly pay roll is in the neighborhood of $10,000. Much of the work turned out is of a special class, as is evinced by contracts recently completed, which include a steel naval training ship, the speediest torpedo boat ever built in America, and the most powerfully-engined privately-owned pleasure craft in the world. The Bath Works has also refitted a number of the United States transports, at an expense in excess of $100,000 each. Considerable naval tonnage, including one of the cruisers of the Denver class, is on hand at the present time. The same spirit of expansion so universal among American ship-yards of late is observable in the case of the Bath Iron Works.

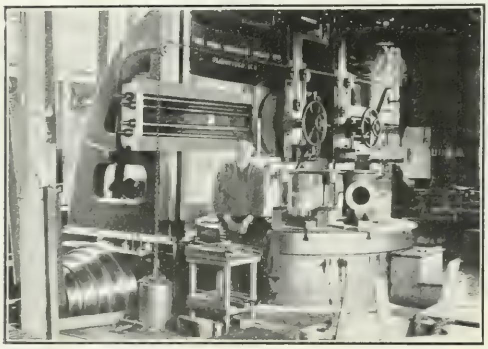
MACHINE SHOP AND BOILER SHOP, ATLANTIC WORKS, EAST BOSTON, MASS.

Several new buildings have been constructed within the past year, including a modern brick and steel fire-proof machine shop 310 feet in length by 100 feet in width. There is a steel crane capable of lifting 100 tons, and new tools have been added in all departments, so that the equipment of the plant from the 23-ton plate roller down is now complete in every essential.

The only other steel-ship-building plant at Bath is the yard of Arthur Sewall & Co. This firm was formerly engaged in the construction of wooden vessels, but about five years ago the yard was transformed into a plant for building steel vessels, and a number of steel sailing vessels of 1,800 to 2,000 tons' burden have been constructed. The principal concerns engaged in wooden construction are the New England Company and Kelley, Spear & Co., each of which gives employment to between 300 and 400 men.

SHIP-YARDS OF THE ATLANTIC WORKS, EAST BOSTON, MASS.

While the ship-yards of the New England coast are under consideration, attention should possibly be turned to the plants operated in the vicinity of Boston by the George Lawley & Son Corporation, of Boston, the Fore River Engine Works, of Weymouth, Mass., and the Atlantic Works, of East Boston. All three are engaged largely or exclusively in steel ship-building. The Fore River Company's plant at Weymouth, while very complete, was not without limitations in some respects, and the recent securance of important naval contracts

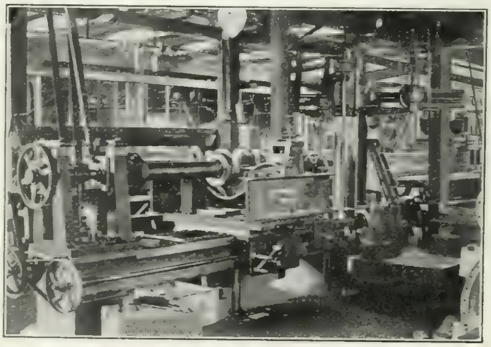


MACHINE SHOP, FORE RIVER ENGINE WORKS, WEYMOUTH, MASS.

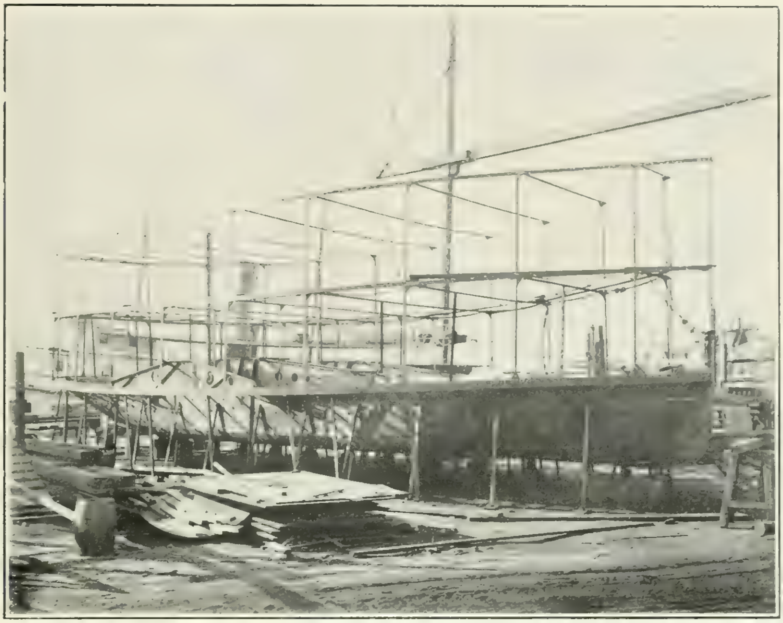
has impelled the company to secure more commodious quarters. The plant is accordingly now being removed to a point further down the river, where deeper water is available. They have here about 60 acres, with a total water front of 1,500 feet on the channel, carrying a depth of 25 feet at low tide and 32 to 35 feet at high tide, with ample width for launching the largest craft. The ship-tool house, now nearing completion, is 390 by 70 feet. The new machine shop will carry in two galleries all the tools in the present shop of the company, leaving the main floor (served by a 25-ton electric crane), free for new heavy equipment. In this will be included four 60-inch lathes, two of which will have beds 110 feet long and two beds 60 feet long. These lathes are designed to turn and bore shafting 45 feet long. There will be a 72-inch lathe for crankshafts, 18-inch slotters, heavy planers, boring mills, and other large tools.

The forge department is to contain three large steam hammers, of 17 tons, 8 tons, and 2¼ tons respectively, besides several lighter hammers. It has a heavy overhead electric traveling crane. Connected with this department will be oil tempering and annealing furnaces.

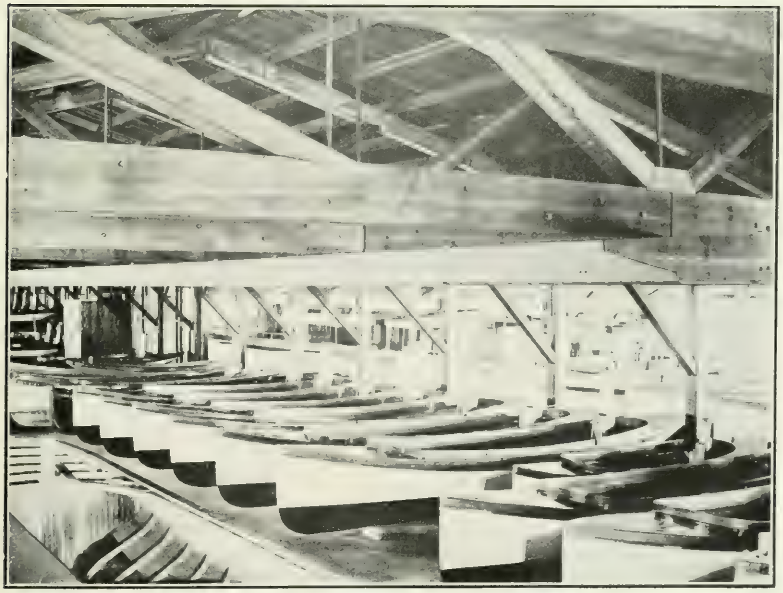
In a separate building is being installed a power plant of 1,000 horse-power capacity, with air compressers for pneumatic tools, as well as the main engines and generators. Electric distribution and driving will be employed throughout, each ship tool, punch, shears, rolls, etc., having its own motor, direct connected. The heavy lathes are being built with a motor substituted for the ordinary cone in the headstock. Locomotive cranes, on tracks in the yards, will serve the various shops.



MACHINE SHOPS, FORE RIVER ENGINE CO., WEYMOUTH, MASS.



STEAMER UNDER CONSTRUCTION IN THE YARDS OF PUSEY & JONES COMPANY, WILMINGTON, DEL.



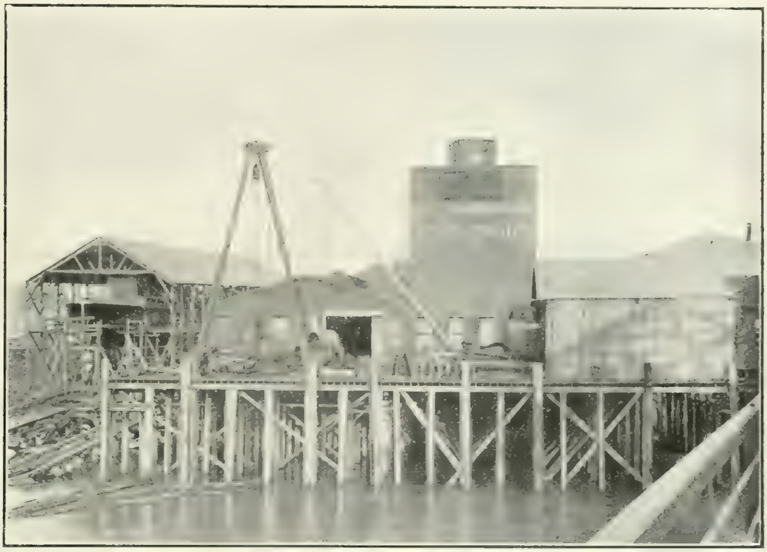
A GROUP OF COMPLETED LAUNCHES.

Yards of Gas Engine & Power Co. and Charles L. Seabury & Co., Consolidated.

In the same general classification as these Massachusetts concerns might be placed a number of institutions on the Atlantic coast, including the Jackson & Sharp Co., of Wilmington, Del.; the plant until lately operated by the Columbian Iron Works Co., of Baltimore, Md.; T. S. Marvel & Co., of Newburgh, N. Y.; Lewis Nixon's Crescent Ship Yard, at Elizabethport, N. J.; the Gas Engine & Power Co. and Seabury & Co., Consolidated, of Morris Heights, N. Y., and the Pusey & Jones Co., of Wilmington, Del. The yard of the last mentioned company, which might be cited as another representative plant of this class, covers seven acres of land and has a water frontage of 1,400 feet. Some idea of the facilities may be gained from the floor areas embraced in principal buildings as follows: machine shop, 43,000 square feet; boiler shop, 11,000 square feet; blacksmith shop, 9,000 square feet; foundry, 21,000 square feet; tool shop, 10,000 square feet, and others in proportion. There are seven sets of launching ways and a 100-ton lifting sheers. The yard employs from 700 to 1,000 men and the weekly pay roll is in the neighborhood of $7,000 per week. Lewis Nixon built the submarine torpedo boat Holland, and his yard is largely given over to the construction of vessels of some special class. The Gas Engine & Power Co. and Seabury & Co., Consolidated, although they have had a torpedo boat under construction for some time past, devote almost all their attention to steam yachts of all classes.

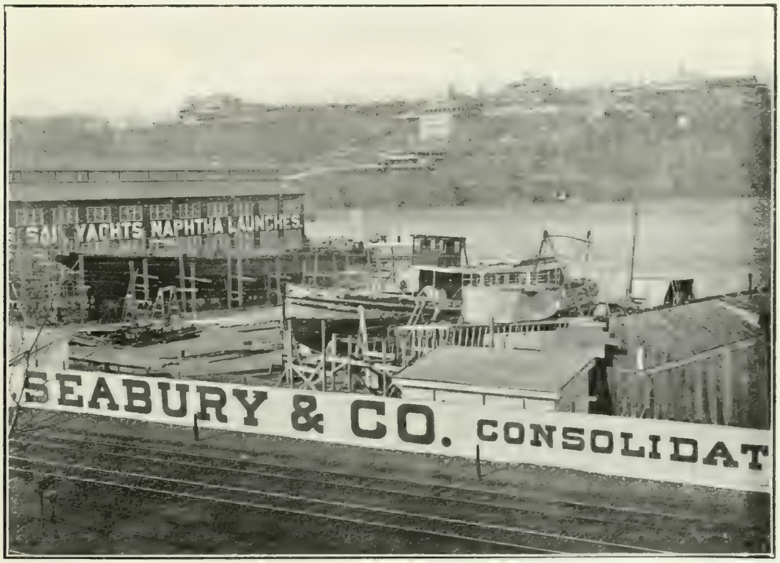
THE PUSEY & JONES COMPANY'S YARDS, WILMINGTON, DEL.

The only yards on the Pacific coast, aside from the Union Iron Works, which build steel vessels—the Wolff & Zwicker Iron Works, of Portland, Oregon, and the Moran Brothers Co., of Seattle, Wash., might be classed with the yards just mentioned; so also might the Iowa Iron Works, of Dubuque, Iowa, practically the only steel-ship-building plant on the inland rivers. The Pacific coast concerns took up steel

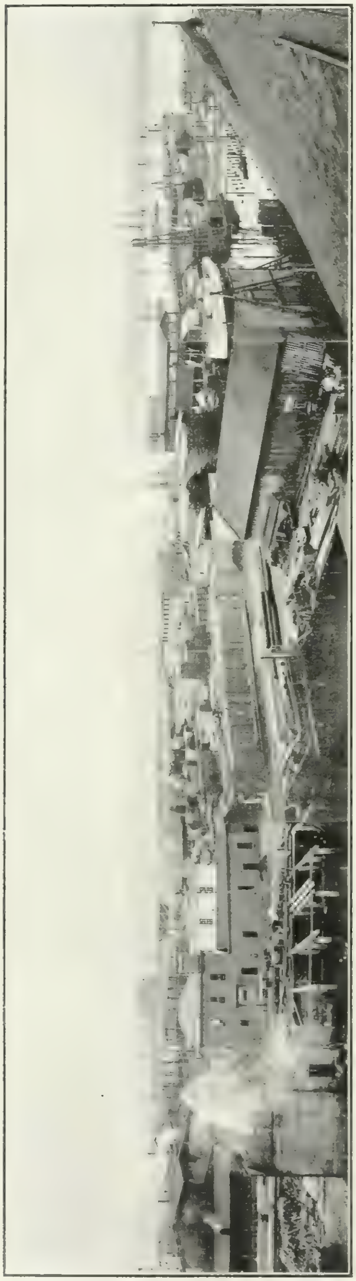


WOLFF & ZWICKER IRON WORKS, PORTLAND, OREGON.

ship-building only a few years ago, but the measure of their success in the field may be imagined from the fact that they have each within the past twelve months turned out one or two torpedo boats which exceed



GENERAL VIEW OF PART OF THE YARDS OF THE GAS ENGINE & POWER CO. AND CHARLES L. SEABURY & CO., CONSOLIDATED, ON THE HARLEM RIVER, NEW YORK CITY.



PANORAMA OF THE YARDS OF THE MORAN BROTHERS' COMPANY, SEATTLE, WASHINGTON.

contract speed. Both yards are now crowded with work, including some craft for Alaskan river service. The Iowa Iron Works built a United States revenue cutter and the torpedo boat Ericsson some time ago, but of late have confined their attention largely to steel tenders for the Mississippi River Commission.

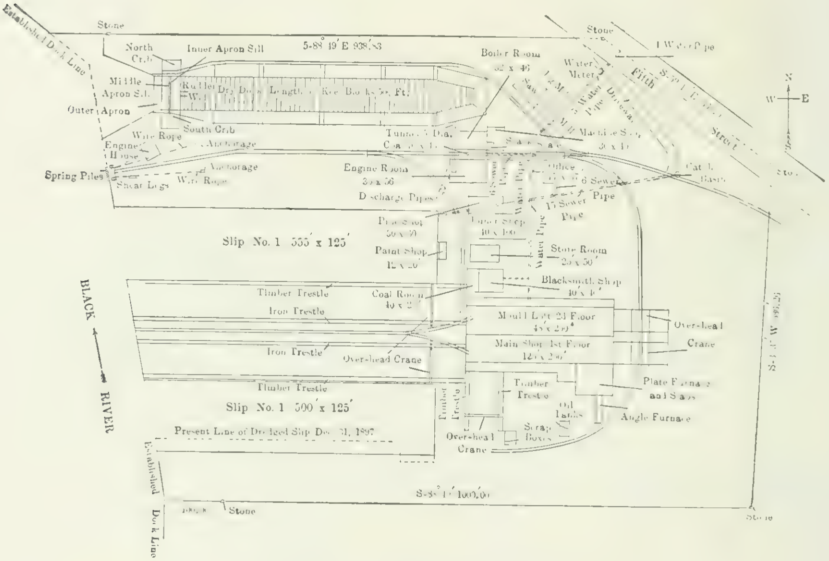
The steel-ship-building yards of the Great Lakes have never been in anything like such prosperous condition as at present. In the spring of 1899 the seven or eight principal ship-building corporations on fresh water, including all the largest plants where steel tonnage is constructed, were merged into the American Ship-Building Company. Five of the plants were put in at valuations close to or exceeding $1,000,000 each, and the lowest was $750,000. The consolidation also gave the new company control of the eleven leading dry-docks on the lakes, for, as on the coast, each yard of any size has one or two dry-docks connected therewith.

In the matter of operation, etc., all the principal yards on the lakes are practically identical. The yards of the American Company at Chicago, Ill., and Lorain, Ohio (formerly operated by the Chicago Ship-Building Co. and Cleveland Ship-Building Co., respectively), are the most modern in equipment and may be cited as most thoroughly indicative of the latest approved practice on the lakes. The Chicago yard occupies about 25 acres, and (as in the case of several of the other lake yards), the vessels are launched into slips at right angles to the river. Inasmuch as the lake builders must launch vessels into narrow waterways, it is the general practice to launch the ship sideways. The type of crane employed for serving material to the ship is the cantilever, with a capacity of 10 tons at the center line of the ships and 3 tons at the extreme length of arm. Five-ton electric cranes are also employed.

At the Chicago yard there is a steel sheer-legs 100 feet high and of 100 tons capacity. There are three legs, the back leg being operated by a horizontal screw to throw the head of the sheers in and out. In the channel shop is a bending machine which will bend cold a 24-inch I beam between supports four feet apart. All deck beams for the ships are cambered cold on this machine. The machine shop is considered by many persons to be the finest marine-engine shop in the United States. It is constructed entirely of steel and glass. The main portion of the shop is 60 feet in width and 60 feet high. On each side of the central portion is a 30-foot wing. In an area, therefore, 200 feet long by 120 feet wide, there are only eight columns to obstruct the view and arrangement of tools. The central portion is served by a 25-ton electric crane. The larger tools in the shop are driven by independent motors, and in each wing one motor drives a line of shafting from which the small lathes and planers are operated.

LAUNCH OF THE SIR ROBERT FULTON AT THE DETROIT SHIP-YARDS.

The system in use for building vessels in the Chicago yards differs not only from the practice of British and European builders but from that in many of the yards on the Atlantic coast of the United States as well. After the estimate of weights on all parts of the vessel has been prepared, a model-block of soft selected pine is procured, large enough to take the half model of the ship on the scale, usually, of a quarter of an inch to the foot. This block is built up of ½ inch strips, solidly glued together with lampblack mixed with glue, showing, therefore, black water lines 2 feet apart. Saw cuts, usually ten frames apart, are put in the block at right angles to its length, and in these cuts are fitted slips of soft red cedar. While finishing the model, therefore, the designer has two sets of lines to guide his eye, the water lines and the cedar sections, and all calipering of the model—alleged to be inaccurate as well as tedious—is avoided, as the cedar moulds can be easily slipped out at any time and placed on paper, and a pencil run around them gives a perfect body plan in a very few minutes. When finally finished, a final body plan is made and scaled and a table of dimensions from it sent to the mold loft. In the loft all of the keel, center vertical keelson, frames, bulkheads, side and deck plating, etc., are laid off and punched from the molds entirely.



PLAN OF THE LORAIN, OHIO, SHIP-YARDS.
A typical lake ship-building plant.

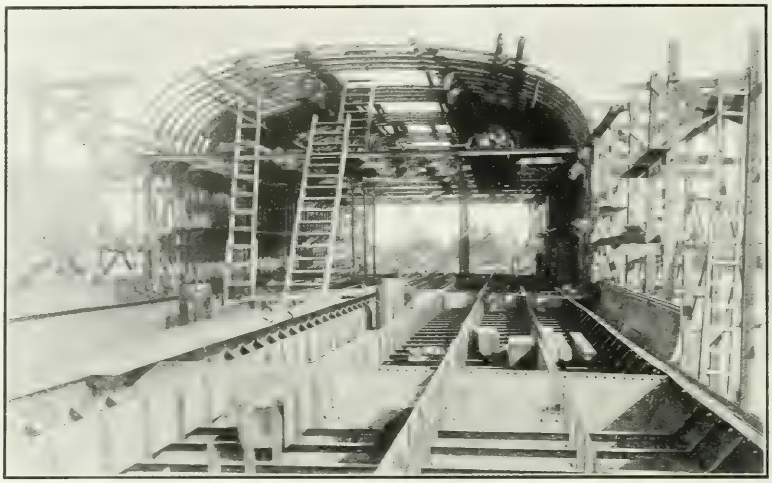
In the construction of the ordinary lake vessel of the larger type, a double-bottom ship, the keel and center keelson, with all the angles

AMERICAN SHIP BUILDING COMPANY'S YARD, WEST BAY CITY, MICHIGAN.

attached thereto, are erected in position on the blocks, riveted and caulked; then the bottom plating is put up and shored. In the meantime the floors, which are usually of channel section, with the bilge

YARD OF THE DETROIT SHIP-BUILDING COMPANY.

brackets, center-keelson brackets, and the stiffening angles for longitudinals, have been bolted together in another part of the yard and riveted up complete on a stationary steam riveter. They are then carried to the ship by the locomotive crane and placed in position across the bottom plating by the overhead cranes. The longitudinals are then lowered into the proper place, and as soon as the necessary squaring and bolting is done, the whole bottom is ready for riveting. Almost immediately thereafter the margin plates of the tank top are put on, and the tank-top plating itself. From this point the construction of the ship goes forward in the usual way.



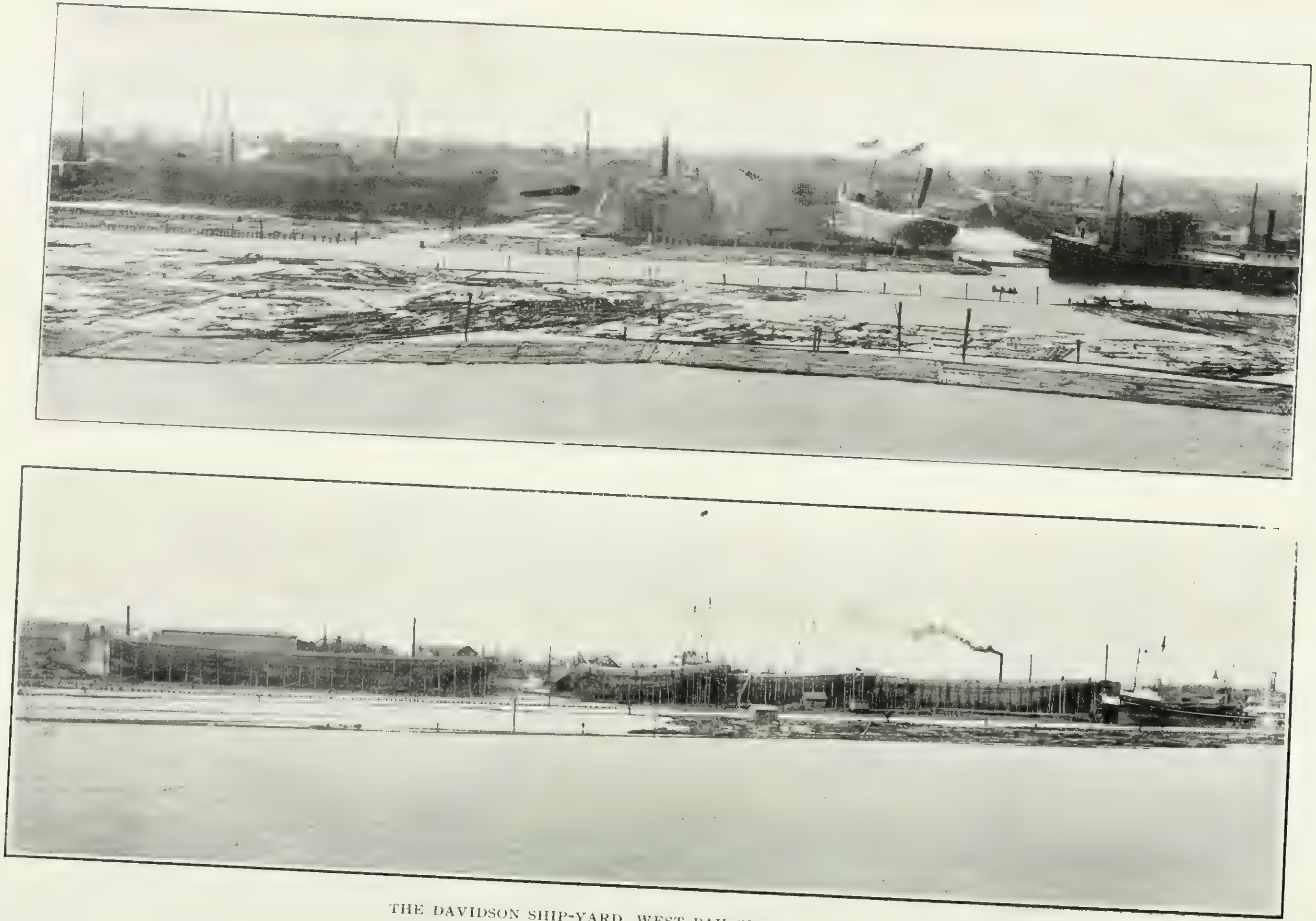
A WHALEBACK VESSEL UNDER CONSTRUCTION.

ONE END OF MACHINE SHOP, WOLFF & ZWICKER IRON WORKS PORTLAND, OREGON.

The development of power riveting has perhaps gone further in these yards on the great lakes than anywhere else. Experiments were undertaken with the pneumatic hammer, consisting of a piston rapidly reciprocating inside of a cylinder and striking the end of the chisel, such as previous to that time had been used for chipping and caulking, and it is now possible to drive every rivet in a ship with machines which are very light, short enough to go in between the frames, and of small diameter. The shell rivets are closed up with the greatest ease and facility. A typical air-compressor at a lake yard consists of a vertical tandem-compound engine with cylinders 19 inches and 32 inches diameter by 42 inches stroke, and compound air cylinders 33 and 19 inches diameter by the same stroke, located one each side of the low-pressure steam cylinder. A complete system of jacket water and a very large intercooler are used, the total capacity of the machine being 3,000 cubic feet of free air per minute compressed to 125 pounds' pressure. From this machine mains are led to all parts of the yard. The magnitude of the pneumatic plants may be imagined from the fact that at the Chicago yard there are in almost constant use over 100 tools.

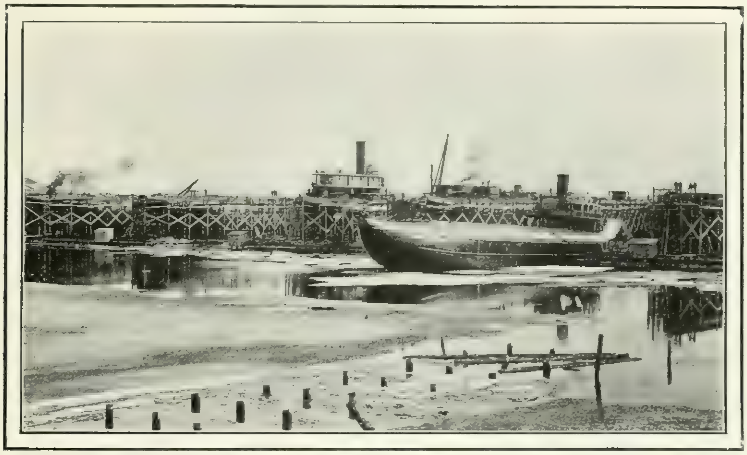
USING PNEUMATIC TOOLS, YARD OF THE CHICAGO SHIP-BUILDING COMPANY.

For launching the vessels sideways or broadside, as is done in all the lake yards, the launching ways are spaced about 10 feet apart from end to end of the ship, and have an inclination of 1½ inches to the foot. Two lines of "sliders," consisting of heavy oak plank, each 30



THE DAVIDSON SHIP-YARD, WEST BAY CITY, MICHIGAN.

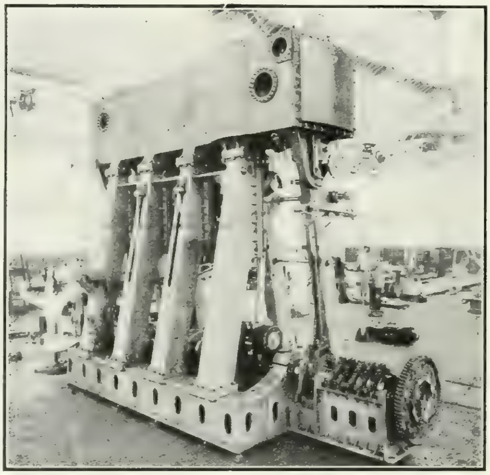
to 40 feet long, are placed fore and aft across the groundways on each side of the keel, and one line of short sliders under the keel. All these are cribbed up to the bottom of the ship, tied together, and wedged. At each end three or four groundways are fastened firmly to prevent moving, and heavy wooden levers or triggers about 10 feet long are placed against projections on their sides, used as fulcrums. From these triggers, dog shores, bearing only about one-quarter of an inch outside of the fulcrum, extend up against the keel and the other ends of the levers are set up by tackles to posts set in the ground.



WEST SUPERIOR YARD OF THE AMERICAN SHIP-BUILDING CO.
Here all the whaleback vessels have been constructed.

The first move in the operation of launching consists in the driving in of the wedges and the transfer of the weight from the keel blocks and shores to the cradle. All the shores are then taken out, and all the keel blocks save three or four at each end. The cradle is on the greased ways, but is prevented from moving by the levers and dog shores at each end. When the triggers are released the shores drop out and the ship is in the water inside of 7 or 8 seconds. Boats are often launched with a drop of 2 or 3 feet from the top of the ways to the water, and occasionally there is a clear drop of 5 feet.

The only one of the large ship yards on the great lakes where wooden as well as steel ships are constructed is that of Capt. James Davidson, at West Bay City, Mich. Outside the "trust," as the American Ship-Building Co. is called, are the Craig Ship-Building Co., of Toledo, O., the Jenks Ship-Building Co., of Port Huron, Mich., and one or two other firms which build steel vessels of what might be called intermediate size. Their specialty is what is known as "Welland-canal-size" steamers—that is, vessels not exceeding 270 feet in length and which can pass through the Welland and St. Lawrence canals. The Craig company has within the past year built two vessels of this size for service in the coasting trade of Puerto Rico, and quite a fleet of steel vessels are now building for service on the lakes in summer and on the Atlantic coast during the winter months. Owing to the provisions of a treaty between the United States and Great Britain, no naval vessels can be built on the great lakes, but several revenue cutters, built on fresh water during recent years, were transferred to the coast during the Spanish-American war and have since remained there.



ENGINES FOR A LAKE VESSEL.

Erected in the machine shop of the Chicago yards.

It may be said in conclusion that whereas the cost of building vessels, both merchant and navy, is at present somewhat higher in the United States than it is elsewhere, all indications point to the approach of a time when superior labor-saving machinery and cheaper material will enable American ship-builders to enter very actively into competition with their rivals in any foreign country.

AMERICAN SHIP-BUILDING COMPANY'S YARD AT LORAIN, OHIO.

THE INDUSTRIAL DEVELOPMENT OF THE ISLAND OF PORTO RICO.

By Albert W. Buel.

THE thing which has impressed most people from the States, on first acquaintance with Porto Rico, is the lack of transportation facilities. This is apparent to the new arrival just off the steamer as soon as he makes inquiries as to the way to reach this, that, or the other town, and learns that a *coche* is a luxurious express equipage, and a *carretera,* or macadamized road is the "best road" or route of the "fast mail" in Porto Rico. The fare, with such accommodations, for a distance of 130 kilometers (80 miles), is 30 pesos ($18 gold). That is less than 20 cents per mile. If the tourist desires to see any besides the principal towns on the island, he will have to be content to ride over a *camino,* or unimproved country road. For a *coche* to go 32 kilometers (19 miles), half by *carretera* and half by *camino,* the charge will be about 14 pesos. If he wants to come back, it will be more. This is only about 75 centavos or 45 cents per mile. Should he desire to penetrate further into the country, he must ride a Porto Rican pony. The roads will be nothing more than mountain trails, and would be both difficult and dangerous to travel on foot. But the ponies are used to them and are perfectly safe. At present this is the only way the most beautiful parts of the island and the best coffee districts can be reached. Another year the *carreteras* will be extended to almost all points of interest on the island.

The country is not more difficult for railway location than some sections traversed by railroads in the United States. This has led men who ought to have known better to advocate systems of railways across the island. The best road the Spaniards built, and it is a good one, has a ruling grade of 7 per cent. and curves of 20-meters radius. The location is in the main good, although there are a few mistakes in it. The road is much longer than the straight-line distance between the towns connected, on account of the windings necessary to overcome differences in elevation without exceeding the ruling grade of 7 per cent. A railroad built on the same line could not cost less than $20,000 to $25,000 per mile. This will give some sort of an idea of what a railroad with grades and curves one-third as sharp would be likely to cost. Grades of more than 2 per cent. and curves of not more than 150-meters radius are not nice to contemplate for any steam railroad. Electric trolley roads can be operated over the grades and curves first mentioned. They could not be given franchises on the roads already graded without practically destroying these for use as ordinary highways. New lines can be located for them, and they can be built for probably $20,000 per mile; but the traffic for years to come could not earn 1 per cent. on the investment over and above operating expenses. This refers to trolley roads in Porto Rico in general. It is possible that a short-line trolley road from San Juan to Ponce, connecting communities of 35,000 to 50,000 inhabitants each, and the two chief commercial centers of the island, would be a paying investment. I have good reasons for believing that a line can be located, not more than 60 to 65 miles long and with grades not exceeding 6 per cent., connecting these two cities. It might cost $25,000 per mile, but would have more than one source of revenue. Should a survey and estimates of cost and probable revenue show that such a road would not be profitable, then any trans-insular railroad project is

BRIDGE ON THE MILITARY ROAD BETWEEN RIO PIEDRAS AND CAGUAS.

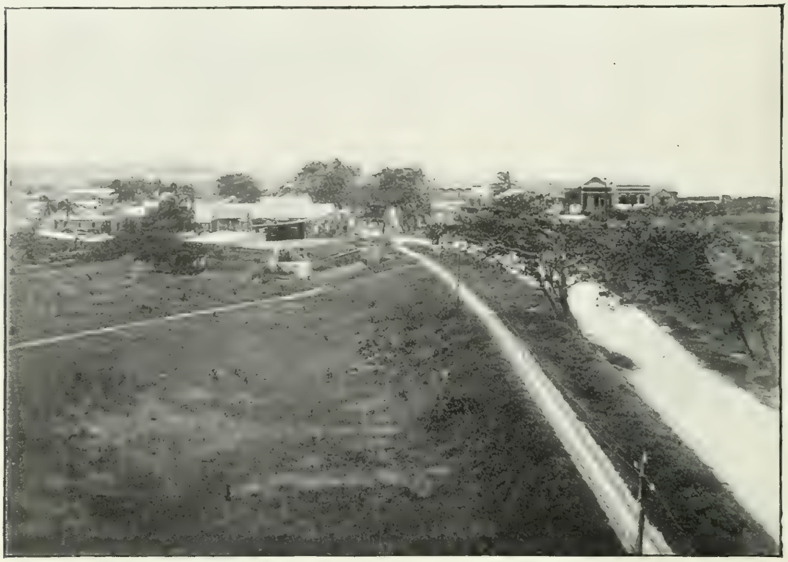
ON THE ROAD BETWEEN PONCE AND ADJUNTAS, LOOKING TOWARD PONCE.

chimerical. City and suburban trolley roads will be built and will pay in the larger towns.

The topography of the island has been well described in previous articles in THE ENGINEERING MAGAZINE. The central part is very mountainous, the summits rising to an elevation of 3,000 to 3,500 feet, with the passes at an elevation of some 2,400 feet. The foothills, if they may be so called, run nearly to the sea, and leave a narrow border of low land skirting the island, from 1 to 15 miles wide. Most of the sugar-cane crop is raised in this strip, while the coffee and tobacco is raised in the mountains in the interior. The French railway, of one meter gauge, is projected to belt the island in the border of low land. It has already in operation 69.5 miles, from Carolina to Camuy, via San Juan; 27.3 miles, from Aguadilla to Hormigueros, via

Mayaguez; 26.7 miles, from Ponce to Yauco—a total of about 123.5 miles, leaving about 150 miles to build to complete the belt line railroad projected.

The harbors of the island are not numerous or any too good, and only at San Juan and Ponce has anything been done to improve them.



RAILROAD AND MILITARY ROAD LEADING INTO SAN JUAN.

The expenditure on the harbor of Ponce has not exceeded 50,000 pesos, while about 1,100,000 pesos has been spent on the improvement of San Juan harbor since January, 1883; about 80 per cent. in dredging and the remainder in works more or less temporary. There were projected, during the Spanish *régime,* extensive harbor improvements of a permanent nature for San Juan, Ponce, and Mayaguez, respectively, on the northern, southern, and western coasts. The works to put these harbors in condition to provide economical facilities for commerce will cost a large amount of money, and if a harbor on the southeastern coast is added to those to be improved, the funds likely to be available for this purpose for a number of years will be absorbed by these projects. The great cost of making harbors at many other points, owing to the nature of the coast, puts out of the question any project for a coastwise service sufficient for local traffic.

The island is nowhere wider than 35 to 40 miles, and the distance by road, from any point in the interior to the coast, is not more than 40 miles, and when the roads under construction are finished, 20 miles ride from the coast will reach most points. The average haul will hardly exceed 15 miles, from the interior to the coast. The direction of the heaviest traffic will always be towards the coast and therefore down hill. It is, therefore, doubtful if trolley roads could get much of the business of hauling coffee and tobacco to the port, in competition with improved highways. The highways around New York city successfully compete with well built and equipped railways for distances as great. Moreover, time is not much of an object in Porto Rico. Of course, sugar is a heavy crop on the island, but the bulk of it is produced near the coast, on the line of the French railway, by which route it reaches, or will reach, the ports.

With these conditions in view we may outline a rational and comprehensive project for the improvement of the transportation facilities of the island: First, construct improved highways direct from all points in the interior to the coast by the shortest practicable lines. Second, construct a highway around the island, and near the coast. Third, complete the belt-line French railway. Fourth, improve the harbors of San Juan, Ponce, Mayaguez and Jobobs or Naguabo. The last item will cost more than all the other three put together, but it is a *sine qua non.*

THE FRENCH RAILWAY. SAN JUAN IN THE DISTANCE.

Then all the products of the island can reach the coast by a short

RAILWAY BRIDGE CROSSING THE MANATI RIVER.

down-grade haul, and thence may reach an improved port either by rail or by highway, the latter being a check on the tariffs of the former. Having provided means for carrying the products of the island, we may next devote attention to increasing these products and improving their quality.

At present the three chief products of the island are, in order named: Sugar, coffee and tobacco. There is considerable cane land not under cultivation, and with proper conditions no doubt the sugar crop can be doubled. The cane mills are many of them in bad repair and use the old process. With improved "sugar centrals" there would undoubtedly be a saving in cost of production.

RAILWAY BRIDGE BETWEEN SAN JUAN AND SAN TURCO.

The coffee of Porto Rico is, in the opinion of experts and epicures, the best in the world—or, at least, unexcelled. It is now a large crop, but the island is capable of producing many times as much. The crop is quite profitable after the first few years.

It may be noted in passing that the very best coffee lands are in the most beautiful parts of the island, and while they are not to-day easy of access, they will be within six months from the time this is written. There are many places that would make ideal winter resorts for those who can indulge in such luxuries. One could have a winter resort in the mountains of Porto Rico that would be a source of profit within five years. Practically all the work is done on a coffee plantation during the winter months, when the northern owner would naturally be there. The valley of the Rio Grande de Arecibo is certainly unexcelled in beauty by anything I ever saw in the United States. The weather bureau publishes so much literature, with figures, maps and tables, on the climate of the island, that any further remarks on the subject of its perfection are superfluous.

PORTO RICAN AGRICULTURAL INDUSTRIES. COFFEE DRYERS AT UTUADO.

Porto Rico tobacco is not Havana tobacco, but there is more difference in the way the two are handled, cured, and sorted than there is in the leaf itself. I have yet to find a box of Porto Rican cigars that runs uniform. One cigar will be the equal of an Havana, and another from the same box will be mediocre. The improvement in handling will follow the introduction of the tobacco in the United

States market, after which there should be an increase in the demand and production.

The orange flourishes, and is not in danger from frosts that have played such havoc with the groves in Florida. It is confidently believed that the Porto Rico orange crop will in a few years be a leader in the orange market.

The cattle of the island are fair, but the milk is thin and will not produce cream or butter. The stock needs the addition of some Jersey blood. The ponies are small but tough. There is no doubt that any care at all in their breeding would give better results.

Porto Rico is an utter stranger to emulation, and is not well acquainted with competition. As soon as the highways are constructed it would be wise to divide the island into six or seven districts, with San Juan, Arecibo, Mayaguez, Ponce, Cayey, etc., as the centers of the districts, and institute annual district or county fairs. These people take to carnivals naturally, and I have no doubt that they would be a success from the start if properly managed. With prizes of money (or a gaudy decoration) it is possible that some little emulation could be cultivated, to the benefit of the quality of the products of the island. Such fairs would bring out (not for sale) a truly marvelous display of women's work, in laces, drawn work, etc., and also of guava and other *dulce*. If the district or county fairs were held

PORTO RICAN PLANTATIONS. HACIENDA LAS CLARAS, ARECIBO.

Sextuagesima week, an insular fair could be held at San Juan during carnival week, which would well be worth the voyage from the States to see.

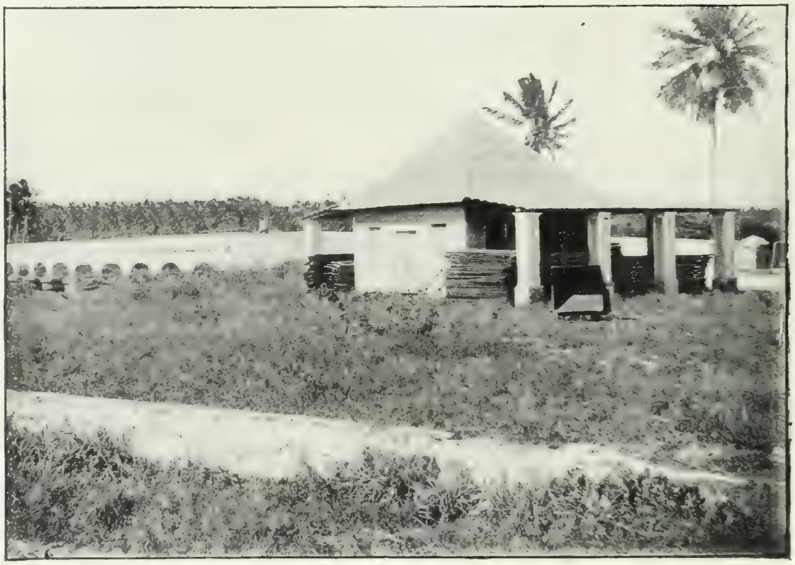
All the preceding remarks or notes have referred to lines of development that might be hoped to show immediate or quick results. The eventual and proper development of the island, however, can only be attained by that long line that has a generation as its unit of time—

PORTO RICAN PLANTATIONS. HACIENDA LOS CAÑOS.

EDUCATION. The United States military government found the island practically without a school system. True, they had schools; and in San Juan a most creditable high school, judging by the capacity and educational acquirements of its graduates. But they had no school houses.

The civilized world will judge the United States to a large extent by what they do in educational matters, for all advancement rests on education.

The American insular board of education has built one school house, and the entire history as well as the result of the effort is almost an epic on "how not to do it." As an illustration of architectural taste it is barbarous—a blot on a fair island, and representative of the worst taste in America. It is set on a hill and is one of the first objects noticed from the bay. It is very impressive—very ugly and repulsive things usually are—but this is especially so because repulsive architecture is rare in San Juan. Thus the first effort of the new school board



ON THE MILITARY ROAD NEAR MATIN PEÑA, SHOWING A ROADMAN'S HOUSE

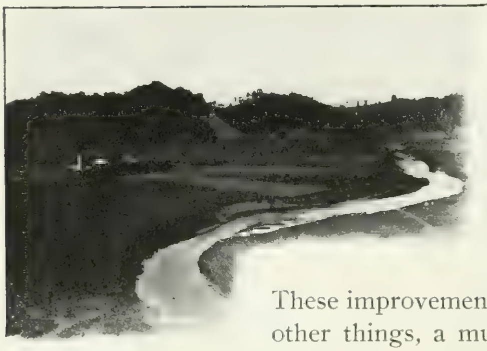
is an example debasing instead of elevating. One's first impression of the "Model and Training School," before reading the sign over the door, is that it is a quartermaster's temporary storehouse. The matter most to be regretted is that this hideous appearance has not saved any money. The building has cost more than the original estimate by two additional appropriations. And now they tell me that it is settling and will not bear up ordinary school supplies. There is one thing about it that is very fortunate—it is not fire-proof.

Other things the insular board of education has accomplished are introduction of American non-Spanish-speaking teachers for Spanish-speaking children, and the substitution of English for Spanish; the appointment of almost illiterate American adventurers to such positions as district superintendents, and the appointment and retention of intemperate men to responsible positions in charge of the schools. It is right and proper enough to introduce English, but the change of language should have occupied several years instead of only one.

The houses in San Juan are mostly constructed with massive brick walls and wooden beams for both floors and roofs, supporting brick or tile. The roofs are all nearly flat and consist of three courses of brick, each about 1¼ to 1½ inches thick by 12 inches long, laid on 3 inch or 4 inch by 1 inch wood slats or lath, spaced the length of the brick apart on centers. The brick and mortar are of very poor quality, hence the thick walls are rational. The wood may be one of several native varieties, probably ausaba—a hard, tough, and durable timber, but very expensive. Where the beams enter the walls they soon decay, because the brick are very porous and are always nearly saturated with moisture. The walls are plastered inside and out, and the joists always show in the ceiling, only having their edges chamfered and painted a stripe of blue or sometimes orange. Most of the walls and ceilings are white, with trimming of subdued tints of green. The exterior walls are subdued tints of all colors, and the effect is pleasing. When some enterprising Americans introduce concrete-steel beams here, San Juan will become the most durable and fire proof city in the world. There are few places where concrete-steel has conditions so favorable for competing with wood and steel.

San Juan has good pavements, kept clean by the board of health, using prison labor; it has a water works and the beginning of a good system of sewers. It has three or four paved plazas, but no park. The streets are narrow, very, and there is a congestion and overcrowding hard to find in the United States outside of the lower east side of Manhattan Island. The two causes of this state of things are the ancient inherited desire on the part of everyone to live inside the walls of the old fortified town, and the fact that almost all the available land for extension on San Juan island is, and always has been, government property. Just before the war the Spanish government had arranged to release a large part of this land for the extension of the city, and extensive improvements were planned on it. These were stopped by

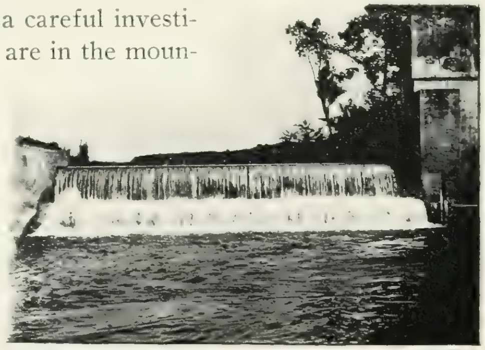
IN MAYAGUEZ. THE ONLY TRAMCAR LINE IN PORTO RICO.



RIO DE LA PLATA, AT TOA ALTO.

the war, and will probably have to await the enactment of the civil government bill by Congress before they can be proceeded with and the unhealthy (both physically and economically) condition of congestion is improved. These improvements ought to comprise, among other things, a municipal park, a hotel to accommodate the increasing number of tourists from the States, as well as others, and some apartment houses. These would certainly be good investment for American capital, considering the demand, the ruling prices, and the small expenditure involved compared with similar projects in the States. With proper accommodations supplied, there is no reason apparent why San Juan and Porto Rico should not be a most popular winter resort.

The opportunities for developing great water powers are so large in comparison with the size of the island that they may be said to be unlimited—that is, physically. Where to find a market for the product, whether it be converted into electric current, compressed air, or any other form of energy, is the question. Certainly there exists already a demand for a limited amount of electric current for both light and power, but whether or not there is a sufficient demand in sight to warrant the development of the water powers and the stringing of the copper is a question that to answer in a way worth anything will require a careful investigation by an expert. There are in the mountains some of the most perfect natural locations for high masonry dams, with the bulk of the material right at hand to build them, that can be found anywhere in the world. The high price of fuel on the island also points to the development of these water powers.



DAM ON BAYAMON RIVER, PALOSECO.
Furnishes power for an ice factory.

PORTO RICAN WATER POWERS. THE RIO COROZAL.

The poor quality of the Porto Rican brick has already been mentioned, but, like almost everything else on the island, its imperfections are not the fault of the raw material supplied by Borinquen—the ancient Indian name for Porto Rico, meaning "the beautiful island." Whoever made this island did a good deal for it; man has, up to date, done almost nothing. There are clays available in quantities for all grades of brick, tile, and crockery. The natives are well adapted to that kind of work, and they only need direction, with the proper plant, to produce excellent results. The island has about one million inhabitants, and would afford a market for clay and pottery works of fair size.

The consumption and imports of Portland cement for the island for the current year will exceed 20,000 barrels. The consumption will increase in future years. If proper raw materials can be found on the island, and there is every reason to believe that they can, the manufacture of Portland cement should prove very profitable. The greater cost of fuel for burning, compared with the cement mills in the States, would be balanced partly, if not entirely, by the lower price of labor. Moreover, for local consumption, it may be shipped in bags, while cement for export over sea must be coopered. The cost of the cooperage will more than offset all other disadvantages. Besides these there is the difference in cost of freight. The present consumption on the island alone would make a nice business for a small mill, and the profits in this business are large, under present conditions of supply and demand. It is quite probable that a well managed Porto Rican Portland-cement mill could eventually supply a large part of the demand for the article in the West Indies, Central America, and the northern part of South America, and could sell all it could possibly make when the isthmian canal is constructed.

Another possible line of development is indicated by the luxurious wild growth of bamboo. The cultivation of this product and its manufacture into various articles, for which the Porto Ricans are peculiarly adapted, might be developed into a flourishing industry.

It has not been my object in these notes either to write exhaustively of Porto Rico or of the subjects touched upon, but rather to suggest some of the lines deserving further and special investigation for industrial development and investments. At the same time, and this is of no less importance, it has been my intention to show that some lines do *not* invite further consideration, at least, not yet.

That Porto Rico is susceptible of wonderful improvement and industrial development is as self-evident to anyone who sees it as that it is one of the most beautiful, lovely, and fertile spots on earth. But nothing can move until the political status of the island is settled. Whether that improvement is about to dawn, or whether the island is to continue to exist as it has for four hundred years, or, as has seemed latterly, while the politicians were using it as a pawn in a game of chess, it is to retrograde, depends on the fulfilment by the American people, their Congress, and their government, of the trust they have assumed. This, I hope and believe, will be carried out with the highest sense of honor.

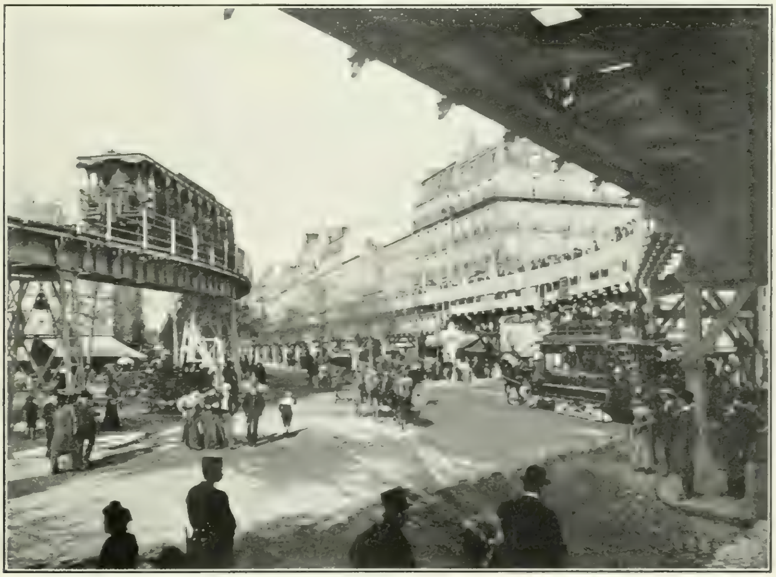
LOCAL TRANSPORTATION AT THE PARIS EXPOSITION.

By Henry Harrison Suplee.

THE practical problems which present themselves in connection with the operative management of a great exposition are often as instructive as the exhibits themselves.

Nearly all modern cities are now contending with the difficult problem of local transport. In the natural order of things there is a business quarter and a residence quarter, or rather, several residence quarters, and twice a day the human tide flows with an ever-increasing volume. If such a problem is difficult in ordinary circumstances, it is far more complicated when a vast increase in the floating population is made, and when the force of the human current is concentrated upon a comparatively limited area.

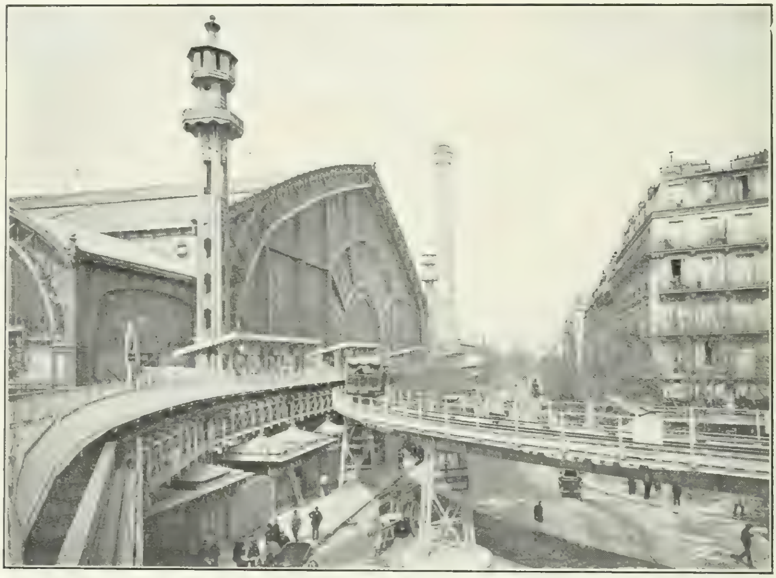
In Paris we see these latter conditions carried to an extreme, and the manner in which it has been attempted to meet them may furnish some lessons, not only for the conduct of transportation at future expositions, but also in cities now contending with an acute state of street



A CROWDED CORNER, SHOWING ELECTRIC RAILWAY AND TRAVELLING SIDEWALK OVERHEAD.

congestion. Paris is an excellent example because of its nearly circular shape, because of the central location of the exposition, and because the circumstances have rendered possible the use of both rail and water transport, as well as of horse-drawn vehicles innumerable.

Normally Paris has been dependent upon two means of local transport—the omnibus and the cab. To these have been added gradually certain tram lines, using steam, compressed air, and electricity. But these latter have been slow and very limited in capacity. The belt-line railway, running largely in cuttings and underground, has done something to relieve the congestion for such travel as could be reached by its limitations. An additional and more agreeable means of conveyance is found in the small steamboats plying on the Seine, and making frequent stops on both sides of the river. For many years, however, it has been realized that these facilities were unequal even to the ordinary demands for transport, and in view of the present exposition, numerous preparations were made for improvements.



SIDEWALK AND RAILWAY AT THE AVENUE DE LA BOURDONNAIS.

As a matter of fact, however, none of these improvements has been completed in time excepting those within the exposition grounds. The "Métropolitain de Paris," the fine new underground road, extending from the Porte Maillot to the Porte de Vincennes, on the right bank of the Seine, with a spur to the Place du Trocadero, was almost completed at the opening of the exposition, being "all finished except the finish-

ing," but up to midsummer it had not been opened to travel. Doubtless this route, touching as it does at the Place de la Bastile, Hotel de Ville, Palais Royal, Tuileries, Place de la Concorde, Champs Elysées, Place de l'Etoile, Place Victor Hugo, and the Place du Trocadero, will be of immense value in facilitating transportation between the east and west of Paris, and it will be a most valuable legacy of the exposition to the service of the city. The whole scheme, of which the above is only a portion, is far greater in extent. Section B will follow the line of the old exterior boulevards, thus forming a circle within the present ceinture line. Section C will unite the St. Lazare station, the Opera, the Bourse, and the Place de la République, and connect with the circle at the Boulevarde de Ménilmontant. Section D, starting from the extreme north of Paris, will connect the stations of the Northern and Eastern railways, and will then pass under the Seine near the Louvre, connecting with the Montparnasse station and extending to the Porte d'Orleans on the south. Section E will connect the station of the Easern Railway with the Austerlitz Bridge, and section F will extend from the Austerlitz Bridge to the Place d'Italie.

THE CROWDED SEINE BOATS.

Since none of these excellently planned lines was ready for operation at the opening of the exposition, the visitors during the first half of the time have had to depend upon the existing means of transportation, with such slight increase in capacity as had been provided. As a result, nearly every line of conveyance has been most seriously overcrowded. At the omnibus stations, where numbers indicating the order of precedence are given out, the crowds in waiting have extended into the hundreds, while at the boat landings, especially near the exposition entrances, there have been daily long lines of waiting passengers. Much has also been said about the difficulties which have been experienced by the visitors with the cab drivers, but in justice to these latter it should be said that many of the disputes have had their origin in the ignorance of the visitor, or his unfamiliarity with the language, a very moderate advance over the legal rate generally insuring fair service.

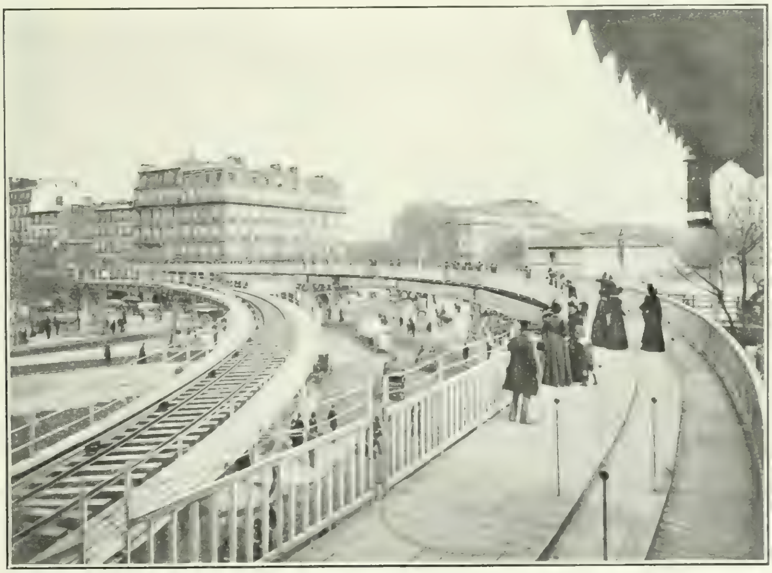
INCLINED APPROACHES TO TRAVELING SIDEWALK AT THE INVALIDES STATION.

As a matter of fact, much of the crowding might have been avoided by a serious effort to augment the existing facilities. A number of additional boats for the river could have been obtained from elsewhere, while a service of electric and steam launches upon the Seine, similar to that so successfully used at Chicago in 1893, would have done much to relieve the congestion. Such launches would have secured innumerable commissions from visitors, since the river forms a remarkable water-way through some of the most effective portions of the exposition, and would have proved convenient and profitable.

The capacity of the omnibus routes, at least, could have been increased by putting on additional vehicles upon the most crowded lines, for in any case a great augmentation in omnibus travel was sure to have been anticipated, while automobile cabs by no means utilized the great opportunity which the exposition offered.

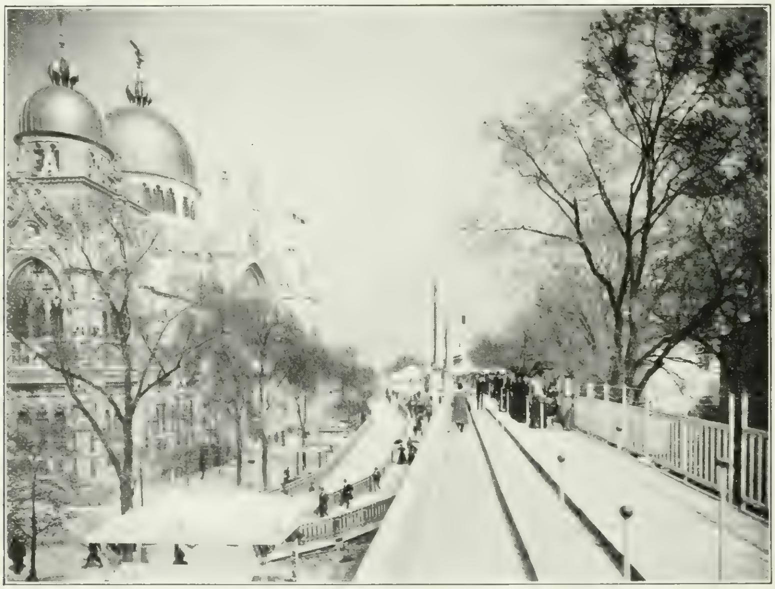
Leaving the question of what might have been, it is more interesting to turn to the operative means of transport within the exposition grounds. These are practically limited to the traveling sidewalk and the electric railway.

The first of these, the traveling sidewalk, while by no means new in conception, is here carried out on a far larger scale than ever before attempted. Extending for a length of 3.4 kilometers around the quadrilateral formed by the Rue Fabert, the Quai d'Orsay, the Avenue de la Bourdonnais, and the Avenue de la Motte-Piquet, it forms a continuous connection between the main portions of the exposition, *i. e.,* the Champ de Mars, the Quai d'Orsay, and the Esplanade des Invalides. The only portions not directly reached are those on the right bank of the Seine, the Champs Elysées and the Trocadero, and these are readily reached by crossing the river by the Alexander III. bridge or the bridge of Jena. The general appearance of the platform is well shown in the illustrations, and its construction was described in THE ENGINEERING MAGAZINE before its operative success had been demonstrated. The mechanical operation is very simple, thanks to the ease with which power may be electrically distributed. It is understood that the main platform of 2 metres' width travels at the highest speed, 8 kilometres per hour, while the auxiliary platform, of about half the width, travels at half the speed, the third platform re-



CURVES ON THE ELECTRIC RAILWAY AND THE TRAVELING SIDEWALK maining stationary. At every 200 metres there is placed beneath the platforms an electric motor, there being 172 motors in all, these being partly of the Alioth type and partly of the Westinghouse. The motors operate shafts extending across the framework, these shafts carrying driving-wheels of two diameters acting upon rails attached to the under sides of the two sections of the platforms. The motors, being carried upon spring suspensions, are held up against the rails driven by them with a uniform pressure, so that unnecessary friction is avoided, and in practice the whole operates remarkably well, there being very little or no jarring or irregularity.

The power required to drive the platform is much less than might have been supposed, varying between 220 and 330 kilowatts (300 to 400 horse power), according to the load. This certainly appears reasonable when it is considered that the platform itself weighs 1,700 tons, and carries an average of 14,000 to 15,000 persons at a time. As will be seen from the illustrations, the method of jointing the sections of the platform permits curves of short radius to be turned without opening any gap, and although the construction of the whole has necessarily been performed in a very limited time, the appearance is by no means unsightly.



THE TRAVELING SIDEWALK, SHOWING THE APPROACHES AT THE GARE DES INVALIDES.

It is especially interesting to observe the ease with which all persons, old and young, of either sex, mount and descend from the plat-

SHARP CURVE NEAR THE EIFFEL TOWER.

form, and even the brief experience which has been had already shows how entirely practicable the system is in this respect for general use. This matter is especially important in connection with the transportation of large numbers of people for comparatively short distances, since a large portion, both of time and energy, are wasted in the frequent stops required by ordinary tramway systems. The movable platform, or traveling sidewalk, enables the entire length of the route to be utilized, and the absence of stops makes up, in great measure, for the moderate speed at which it travls.

Taking into account the remarkable success of the system of Messrs. Blot, Guyenet, and de Mocomble, at the exposition, it remains to be considered how far such a system, or some modification of it, is applicable to general service. For many local purposes it requires practically no modification. Thus, for example, in the long platforms at railway stations, on piers, or for connections between stationary platforms, where large numbers of persons are to be transported for short distances, much of the congestion now so annoyingly frequent might be removed. The same is true in large machine works, where much of the time now lost in passing from one part to another might be saved by a travelling platform and the rush of workmen at the hours of opening and closing transformed into continuous streams without crowding or confusion. Enormous economies have been effected in the handling of materials by use of endless traveling belts and conveyors, and it is probable that similar methods may be installed locally for very many varieties of service.

ON THE QUAI D'ORSAY.

When the question of further extension of the traveling-sidewalk system is considered, modifications may have to be introduced. Higher speed can be obtained only by the addition of a third platform, since the essential feature of the system is the fact that it can be mounted by anyone without difficulty, and experience has shown that the speeds used at Paris are as high as can conveniently be employed. With the addition of a third platform, permitting a speed of 12 kilometres an hour, and using a permanent way similar to that of the elevated railways in New York and elsewhere, such a system would go far toward relieving the streets of a great city of much of the congestion now so objectionable. Its use would permit the employment of higher speed electric tramcars upon the surface, since these latter could then be given longer runs, stopping only at given points instead of at every corner. The natural objection to such a system is that of unsightliness, but it is a question whether it would be more unsightly than many things which it would replace. It has never been maintained that the lumbering omnibus of London or Paris is a thing of beauty, and æsthetic considerations have not prevented the plastering of walls, stations, and public places with glaring advertisements. A suitable elevated structure, of correct proportions and mechanical symmetry, need not be hideous and might be made altogether unobjectionable. If Paris, with all the care which has there been taken to render the city beautiful, can permit the erection of such a structure, it is hardly for London or New York to object on æsthetic grounds.

The electric railway at Paris calls for but little attention. It is doing its work well, but differs little from many other tramways operating elsewhere. Following practically the same route as the traveling sidewalk, but running in the opposite direction, its general arrangement is clearly shown in the illustration. The commercial advantages of both systems will be grasped, when it is realized that they must clear their entire cost, with a fair return to the investors and a royalty to the exposition treasury, during six months.

The demonstration at Paris; first, of the excessive congestion due to inadequate service; second, of the ease with which that service might have been improved, should be a lesson to all great cities.

The city of the future, transformed from the city of the present, will have abundant transportation facilities, beneath, above, and on the surface. Electric power will have superseded the steam locomotive and the horse, and, properly conducted, the transformation will remove far more unsightliness, discomfort, and filth than it can possibly introduce.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

III. THE PRODUCTION DEPARTMENT: STORE-ROOM MANAGEMENT.

IN equipping our modern factories with machinery, we are always endeavoring to obtain such tools as will do the work most rapidly and economically. Architects and consulting engineers devote much attention to the best arrangement of power-plant and tools. But the location and arrangement of store-rooms has not received the attention that it deserves.

In glancing over the files of technical publications it will be easy to find a number of descriptions of recently-constructed and "perfectly"-equipped factories, in which not a word is said about the store-room. This used to be true of the drafting department, but with the evolution of the machine shop the drafting room has begun to receive the consideration it deserves regarding its location and equipment. Not so the store-room. Poor store-room management is frequently the cause of delays which entail more loss—and loss which can be more cheaply remedied—than that caused by old-fashioned tools. It is not uncommon to find the store-room in a large factory run by small boys, and with very little evidence that its conduct is characterized by system and order.

If the factory occupies several floors it will be decidedly an economy to have, so far as possible, all supplies needed on any one floor in a store-room on that floor. I have in mind a factory where the elevator was kept going all day long carrying goods to, and distributing material from, the store-room, which was on the top floor. Every workman who needed material was compelled to go up the elevator, and if he wanted two inches of steel, he was given a long bar, which he took down to the first floor, and after cutting off his two inches, he had to take the remainder of the bar up to the top floor again. At the same time, this concern was spending liberal amounts for the purchase of modern machine tools.

Prof. Diemer's papers began with the issue of THE ENGINEERING MAGAZINE for June, 1900. The preceding articles have been:

The Systematized Classification of Shop Orders.

The Production Department: Bills of Material.

If the factory is altogether on the ground floor, as is coming to be the almost universal practice, and a single long room is used for store-room purposes, this room should have more than one delivery window. The stock should be so arranged that a man at the east end of the factory does not have to walk to the west end of a long store-room to get his material. Every few seconds' walk thus saved amounts to many hours in the course of time. For similar reasons of economy, a forty-cent-an-hour man should not be kept waiting at the store-room window until a five-cent-an-hour boy sees fit to climb down from the top of some shelf where he is rummaging. The man who has charge of the store-room should have his headquarters in the store-room and not in the general office. If there is but one large store-room with several delivery windows, there should be push-buttons at each window with an annunciator at the store-keeper's desk, so that he may instantly know of any inattention by the repeated calls from the window where the neglected applicant is waiting.

It is the general rule that castings, instead of being put into the store-room, are piled up on the machine-shop floor; and as orders accumulate and get ahead of the capacity of the shop, more castings keep coming in until there is a perfect wilderness of them piled about, through which the truck-boy winds his tortuous way, and over which men and officers climb and stumble. These castings are piled and re-piled from place to place. Frequently their only identification is by means of chalk numbers marked on them at their arrival, indicating the pattern and order numbers. These chalk-marks soon wear off, and when a machine is to be built a committee of experts has to be called in to find the various parts. Pattern numbers are best cast on pieces wherever it is possible. If it is found desirable to mark castings with order numbers, these numbers are best painted on the casting, for tags and chalk marks are soon lost.

It has been suggested that the overhead carrying of pieces by means of an electric crane obviates any difficulty that may be caused by floor passages being obstructed by castings. But it is poor economy to employ a crane of many tons' capacity to carry a mite of a casting, simply because floor passages are blocked. There are arguments for and against the keeping of castings in a store-room. Where storage room can be found for them, so located that they can be reached easily by a crane, there is no question but that it is best to provide a store-room for them, even if it is necessary to make an extension of a building for that purpose, running a continuation of the crane tracks on into the extension.

Where the factory is divided into departments or sections, as has been suggested in a previous paper, it will frequently be found that section store-rooms are extremely advantageous, since they save much walking and enable the foreman of each section to be of considerable assistance on account of his being close at hand, and accordingly familiar with the contents of the store-room for his particular section. Tools should by all means be kept in a tool-department store-room separate from that devoted to general material.

In the scheme outlined in the paper on "Bills of Material," it has been assumed that it is the duty of the material clerk to see that sufficient material is in stock, or ordered, to provide for orders in hand. In a small establishment, the duties of material clerk and store-keeper may be combined and given to one person. The importance of not allowing the store-room and bill-of-material work to get behind should not be under-estimated, however, and the expediency of having two distinct men for the respective offices should be given the most careful consideration.

The question of how much excess stock should be carried, over and above the actual requirements for orders in hand, is one which should frequently be taken up and considered by the store-keeper in connection with the purchasing agent. Fluctuating prices and possibility of delays in delivery enter into this consideration.

I have seen several attempts made to employ the card system in keeping track of stock on hand in the store-room, each card representing a particular size of some certain article, deductions being made for stock applied to orders in hand, and additions being made as new stock is received. But in the experiments tried the cards did not tell the whole truth, since some material is bound to be lost in the processes of manufacture, and the card-balances did not tally with the actual balances in the store-room. The introduction of the card system for this purpose is hardly to be advocated, for the actual material is the only safe record of what is on hand, while the bills of material serve to check off material required for orders.

It is desirable to set aside all material which it is known will be required for orders in hand. This may be done in several ways. One method which has been tried, but which is not likely to prove practicable in many cases, is to provide a number of large drawers in the store-room, and put all the smaller parts required for any one shop order into one of these drawers. A method more widely used is that of marking with tags all pieces allotted for certain orders, but keeping them together with all the rest of the same kind of stock. In order that this system be successful it is necessary that strict discipline be maintained over every store-room employee, and the severest punishment should be inflicted on anyone applying stock marked for one order on any other order.

In devising shop systems there is always danger of carrying systems to extremes. Where forms are not needed they should be avoided. Thus it is quite apparently unnecessary to set aside and mark for certain orders such material as can be immediately obtained at a moment's notice, such as cap screws or machine screws of standard sizes. The store-keeper should make it his business to see that a reasonable surplus of such standard stock is always carried on hand, over and above all possible requirements. The inspection of the actual stock on the shelves and in the drawers must not be left to boys, but should have the frequent and close attention of the store-keeper personally.

A practical method of accounting for material drawn from the store-room is by means of "Material Slips" signed by the section foreman. A form in use where this method was employed, is given below:

MATERIAL DRAWN FROM STORE-ROOM.

SECTION.................. **DATE**..................

Shop Order	For what part of machine	Material	Quantity
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

..................Foreman.

In this system a separate slip is used for every separate order number. Each day's slips are sent in to a clerk who arranges them according to order numbers, and then posts in the bill of material, opposite each item as specified therein under the column "Material Used," the date and the amount of material drawn. Each day's material slips, after having been posted, are fastened together by a fastener and stored away in some place easy of access. The importance of posting the date is apparent, because if it is necessary to investigate why discrepancies appear between the amount of material specified and the amount actually used, the original material slip is easily located by means of the date.

It is desirable that all material of one kind for any one order be drawn from the store-room at one time. But this is not always feasible. For one machine, or perhaps several machines, on an order may have to be rushed through and finished months before the rest of the machines on the same order are completed.

A part of a bill of material with the postings made on it, is herewith given. In the example given, the order calls for eight machines. The material postings show that two of the machines were built about four weeks in advance of the remaining six.

In the case of some few kinds of material the issuing of a small excess of material may be unavoidable, and in such cases, when the unused excess is returned, a "Credit" notation is made on the bill of material, as is shown in the micanite used for the commutator sleeve in the example given for illustration. Such credit entries are made prominent by posting them in red ink. Where the material slips are used for drawing material from the stock-room a "Credit" material slip on a different color of paper is used in returning such excess material to the store-room.

In a large establishment where the above system had been used for some years, it was found that the process could be much simplified by the complete abolishment of the material slips. In their place the original bill of material belonging to each section was used. For instance, if a man from Section "A" desired material from the store-room for Order "2930", he went to the foreman of his section, was given Section A's bill of material and carried this bill of material to Section A store-room. Here the store-keeper gave him the material desired and posted it direct on Section A foreman's copy of the bill of material and also on has own copy of the bill of material. It was found that with this system the reasons for overdrawing material had to be explained before the material was over-drawn, instead of afterwards.

If a man has already drawn the material required, it is apparent at once on the bill of material, and if a man in any department wants certain material for an order and sees that it has already been drawn by the notation of that fact on his department's bill of material, he will search in his own department for the material, instead of spending the time necessary to go first to the store-room and there find out that the material has already been drawn, or perhaps be given the excess material and then have the matter come up for explanation

BILL OF MATERIAL.

SECTION *D.*
SHIPPING ORDER, *S 3298.*
SHOP ORDER, *C 876.*
8 **MACHINES, TYPE** *K 10.*
TO BE COMPLETED *Oct. 10, 1900.*

DATE, *Aug. 6, 1900.*

Article.	Material.	Size or Pattern Number.	Drawing Number.	Quantity.	Date Ordered.	Date Received.	Material drawn from Store Room.	Total Weight.	Cost of Material.	Cost of Labor.
Commutator.										
Sleeve	*c. i.*	2136	4927	8	8/12	8/17–4 8/18–4	8/21 9/15 2–40 lbs. 6 133 lbs.	173	....	......
Ring	*m. i.*	2137	4927	8	8/12	8/20	8/21 9/15 2–6 lbs. 6–19 lbs.	25	......	......
Nut	*m. i.*	2138	4927	8	in stock.		8/21 9/15 2–8 lbs. 6–25 lbs.	33	......	......
Segments	*c.*	911	2117	576	"		8/21 9/17 144–12 lbs. 432–38 lbs.	50	......	......
Fil. hd. Screws	......	½" x 4"	4928	32	"		8/25 9/20 8 24	......	......	......
Nuts	*i.*	½"	4928	32	"		8/25 9/20 8 4	......	......	.....
Micanite Segs	......	1311	2118	576	"		8/21 9/7 144–3 lbs. 432–9 lbs.	12	...	.....
Micanite Sleeve	......	1411	2634	8	"		*Cr.* 8/21 9/17 *9/18*	23¼	.....	.....
Micanite Ring	......	1412	2634	8	"		6 lbs. 18 lbs. ¾ lb.	....	......	.....

Note: Owing to the size of the page of the magazine this form is necessarily shown on a reduced scale. A liberal width should be allowed in practice to admit of all posting necessary without crowding.

days afterwards when it would be difficult to remember the exact facts of the case.

The giving out of material of any kind in bulk needs to be avoided as much as possible, and facilities should be provided inside the store-rooms for the cutting off of metal rods and bars, fibre, paper, hard rubber, etc., to size, by the placing of hack-saws, band-saws, and cutters inside the store-rooms. If the store-room help spends any continuous time on this work of cutting a quantity of material to size, the time of such help during such periods needs to be charged up to some standing order which will ultimately be charged to Material account, instead of Expense account, to which their time as unproductive laborers would ordinarily be charged.

In tool-rooms, it has been found a good plan in several instances to provide a number of light brass checks, say ten for each employee likely to draw any tools, numbering these with the employee's numbers. When a man draws a tool, one of his checks is hung on a hook provided for that purpose in the place of the tool; or in the case of a tap or die or similar small tool, the check is laid in the recess usually filled by the tool itself. The disadvantage of this system is that the machinist is at the mercy of the clerk in the tool-room, who may carelessly put his check in the wrong place. In view of this fact, it is possible that after all a written receipt will in many cases be most satisfactory, the receipt to be returned to the machinist immediately on his return of the tool in good condition.

Labor done in the tool room will of course be properly charged to the standing order for new standard tools, or to the one for repairs to tools, or, in the case of special tools for certain orders, to the particular order for which such tools are made.

The next article will deal with the practical working of the production department in the execution of the work.

APPLICATIONS OF ELECTRICITY IN THE COLLIERIES OF GREAT BRITAIN.

By Sydney F. Walker.

THE general conditions of working appertaining to a colliery, so far as concerns the work to be done and the power appliances to be used, are of course very similar to those attending metalliferous mining. In order to obtain the coal or ore, except at surface outcrops or where it lies under the mass of a mountain but above the level of the valley beneath, shafts are sunk from the surface into the bed of the lowest seam or deposit that it is intended to work.

In each seam roads are made, in the mass of the coal itself, from the shafts, in various directions, within the area for which a lease has been obtained. In each coal basin a number of mines are worked, each having a certain area of ground below the surface from which the mineral may be taken, and each having also a certain small area surrounding the top of the shafts, within which the engine houses, offices, and other necessary adjuncts are placed.

There are various methods of working, or obtaining the coal, the principal being those termed "pillar and stall" or "bord and pillar," and "longwall." In pillar and stall working, pillars of the coal are left as the work proceeds outwards from the shaft, the object being the support of the strata above, and when the mine has been worked to its boundaries, "working back" towards the shafts commences, all the pillars being removed as the work progresses inwards.

In longwall working the coal is either worked steadily outwards along a long face from the shafts towards the boundary, or, the roads being driven to the boundary, the coal is worked back along a long face towards the shafts. Longwall working is, I believe, gradually displacing other methods in all the coal fields in the United Kingdom.

In either case the miner has to "get" the coal, either with his pick, by blasting, by a coal-cutting machine, or by other means, and to load it into small mine wagons or trams, as they are usually called, holding from 10 hundred weight to 30 hundred weight. When loaded, the

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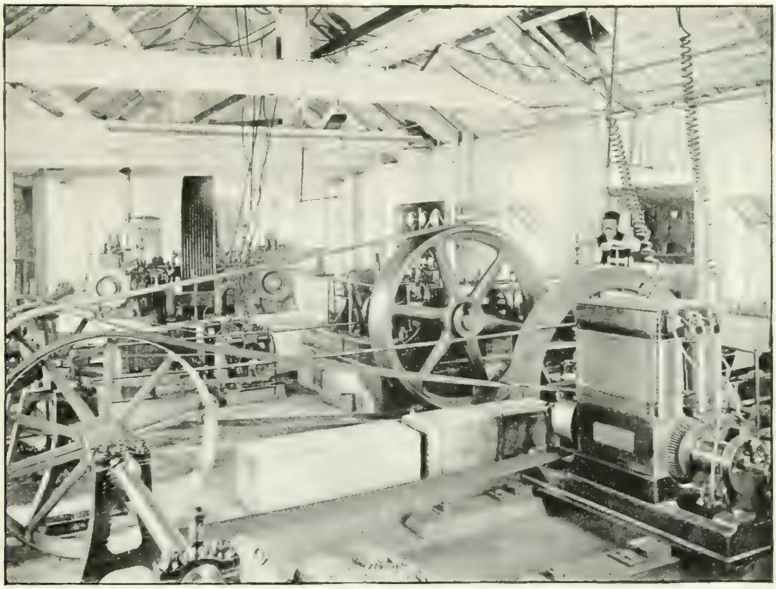
The manifest advantages of electric applications in mining are so rapidly extending its use that even a closely condensed review exceeds the limits of a single article. Mr. Walker's interesting discussion will be continued in the September issue of THE ENGINEERING MAGAZINE.—THE EDITORS.

trams are hauled to the shafts, either by horses or by mechanical power. There they are run on to the cages, which are hauled up and down the shaft by means of ropes from the winding engines on the surface. There the coal is weighed, the number of the miner who filled each tram is noted, and the tram itself is run off to the "coaling" screens, where some method is arranged for separating the small coal from the large, and for removing the foreign matter, shale, stone, etc., which is present with all coal, and for loading into the railway trucks.



ELECTRIC GENERATOR HOUSE, TRAFALGAR COLLIERY, 150 HORSE-POWER COMPOUND ENGINE AT THE BACK.

In addition, the successful working of a coal mine necessitates the constant removal of the rubbish which has to be "got," either in making roads or in getting the coal—the foreign material which exists above and below, and is often found dividing, the seams of coal.

All of those working in the mine, also, have to be provided with air and with light, and in certain portions of the mine special precautions have to be taken that the light furnished shall not be able to ignite an explosive mixture of carburetted hydrogen gas and air, such as is often met with.

Further, nearly all mines are very much troubled by the presence of large quantities of water, in portions of their workings, which must be removed.

Into all of these operations—cutting the coal by machinery, drilling holes in the coal or the rock for blasting, firing the shots, hauling the coal from the working face to the shafts, signaling to the haulage engine from any portion of the haulage road, signaling to the winding engine, communicating between the overman's cabin in the mine and the office, pumping the water from the lower portions of the mine, directing the air current to different portions of the mine, hoisting trams up small "staple" pits from one seam to another, working the moving coal-screening gear, lighting the mine, the surface, the engine houses, the offices—into the working of all these, electricity now enters very largely, and will enter more and more as its great economical advantages are better understood. I believe that the time is not far distant when not only will the steam plant of the colliery be centralised at a main electrical generating station, but one generating station will often supply a group of several collieries.

Where coal is to be brought down by blasting, a hole about 1½ to 2 inches in diameter is drilled several feet into the coal, in a position chosen by the miner as one in which the explosive force of the charge will be most effective in bringing down the coal and in breaking it up into pieces of convenient size for filling into the trams. The charge was fired, in the old days, by a damp straw filled with powder, which was lighted by a miner, who then got himself out of the way. Later this was superseded by the safety fuse, which burnt at a certain rate. Many accidents arose with these methods of firing, owing to men going back to their shot, supposing it to have missed fire, and the charge then igniting.

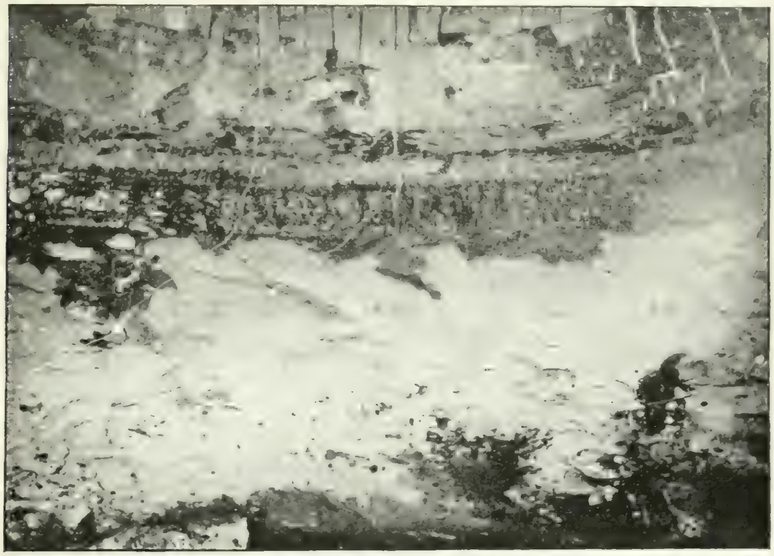
This danger has been overcome to a large extent by not allowing the shot firer to go near his shot for a certain time after he has ignited the fuse, but mines inspectors and mining engineers are now all strongly in favour of firing by electricity, as being absolutely safe and involving no waste of time.

When electricity is employed for firing the shot, an electric fuse is inserted in the charge, having two thin insulated wires connected to it. The wires are made long enough to project a few inches beyond the shot hole. Sometimes two, three, or more shots are fired in the same number of holes simultaneously, and in those cases the wires of the fuses are connected together, so that the current from the electric generator may pass through all the fuses at once.

The fuses are of two kinds, arranged to fire either by the heat generated by the passage of an electric current through a small platinum wire, or by means of the heat and detonating action of a spark passing between the ends of two copper wires. In both cases the wire or wires are embedded in a small quantity of a detonating substance, such as fulminate of mercury, which is able to generate sufficient heat to ignite the charge.

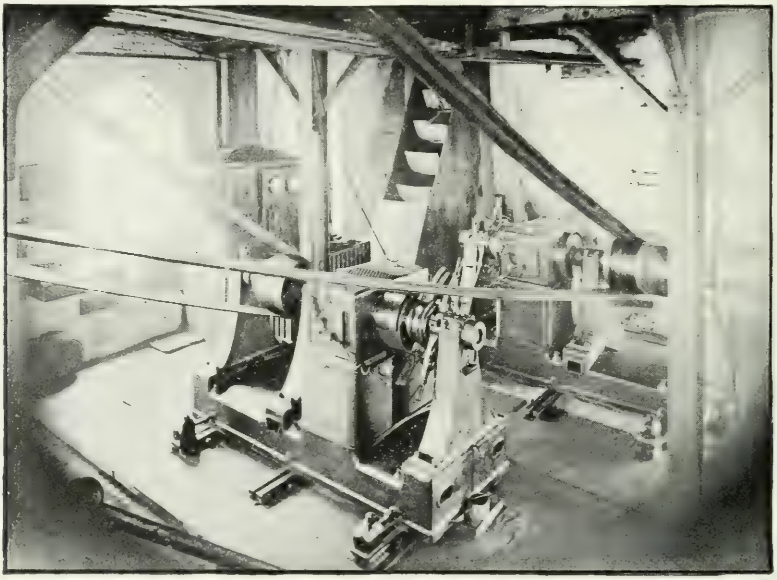
The fuses with small platinum wires which become hot on the passage of a current are known as low-tension fuses, and the current for them is furnished either by a magneto-electric generator, usually called an exploder, arranged for currents of low pressure but of comparatively large strength, by stationary batteries of galvanic cells placed in any convenient positions near the face, or by a small battery of small cells carried in a box which may be slung over the shoulder.

The fuses which fire by means of a spark are known as high-tension fuses, and current for them is furnished by an electrostatic induction machine, or by means of the far handier small magneto-electric machine. This apparatus is constructed with permanent magnets and a shuttle armature, the whole contained in a box, with a leather strap to pass over the shoulder, a handle to turn the armature, and a small push which is pressed when the shots are to be fired. When required for high-tension fuses, the armature of this exploder is wound with very fine wire; when for low-tension, with coarse wire. Arrangements have been made to ignite electric fuses from the electric-lighting service of the mine, by leading the twin wires to the electric light service through a firing key, but in my opinion the plan is very unwise.



A FACE OF COAL WITH WIRES FOR FIRING ELECTRICALLY SEVERAL SHOTS AT ONCE.

For drilling the holes in the rock or coal, electric drills are employed, which consist of a drill driven by gearing for reducing the speed of rotation, a small electric motor engaging with the last wheel of the train and providing the power required. The motors are supplied with current either from the existing service at the mine or by a special plant—usually the former. The supply cables are brought to some convenient spot in the neighbourhood, where an enclosed connecting box is fixed, and flexible cables are taken from there to the motors. Current for the lights is taken from the same service. The electric drills take from 2 horse power to 8 horse power, according to the nature of the material to be drilled, and the current, which varies in strength inversely as the pressure, is supplied at pressures ranging, at the surface, from 200 volts to 500 volts, and at the drills, from 200 volts to 430 volts.

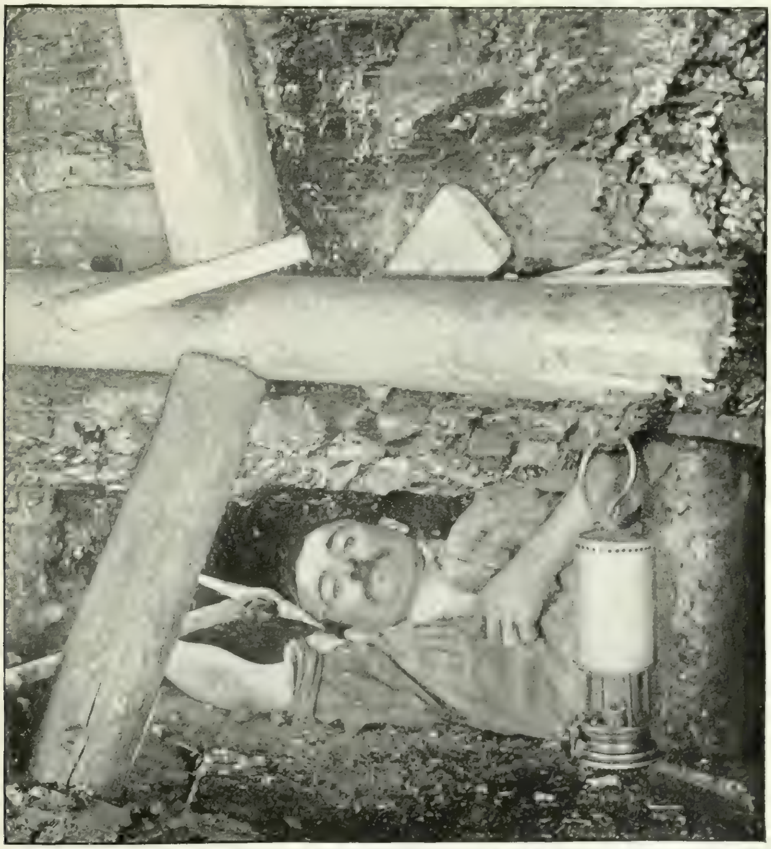


ELECTRIC MOTORS WORKING LUHRIG COAL WASHERY AND SCREENS, ACKTON HALL COLLIERY.

The two motors work onto one countershaft. Either alone is capable of the whole work.

Another method of utilising the convenience and economy of transmission by electricity, which is employed on the continent of Europe, is as follows: The rock drills are driven by compressed air, but the air is compressed at some convenient spot close to the face of the workings, the energy required for compressing the air being transmitted from the surface by electricity. The compressed air is conveyed to the drills by flexible pipes in the usual way. It is a question which can only be decided by actual figures in each case whether anything is gained by this method. An additional conversion of energy, and a somewhat wasteful one, is introduced in the transmission line. The German firm who supplied the plant, however, state that they get a better result than by using electricity all through.

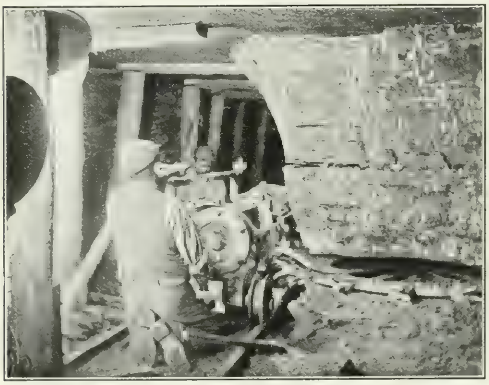
Coal Cutting by Electricity.—The work required from a coal-cutting machine of any kind is the cutting of a channel in the rock under thin coal seams, or in the coal itself in thick seams. In days gone by thin seams were worked by special thin coal miners, who worked in a very awkward position, requiring a special training to enable any work to be done, or any money to be earned. The continued lowering of the price of coal, however, together with the generally increased rate of wages and the gradual extinction of the old-time coal miner,



UNDERCUTTING OR "KERVING" COAL BY HAND, THE OLD METHOD NOW BEING SUPERSEDED BY THE USE OF COAL-CUTTING MACHINES.

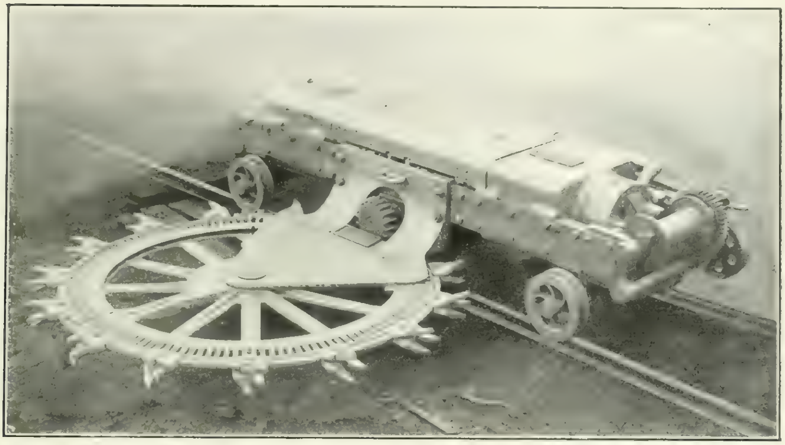
owing to various causes, has rendered hand getting of thin seams commercially impracticable, and so the machine for coal-getting first came into use. But it was soon found that where a machine could be employed, even in thick coal seams, it got the coal in a better form and at a cheaper rate than hand labour, and so the coal-cutting machine is gradually being generally adopted.

Coal-cutting machines have been arranged mainly on two lines. In one form, a disc of iron or steel carries on its periphery a number of cutters, which can be removed for sharpening. The disc is held in a framework, and is actuated by gearing, which is again set in motion by some form of mechanical motor. On the framework, also, is usually carried a small haulage drum, which is slowly revolved by the gearing, hauling the machine along as the cutting proceeds. The early forms of the disc coal-cutter were necessarily driven either by steam or by compressed air (usually the latter), because at that time electrical motors were not far enough developed to be used for the purpose. But as soon as the electric motor became a sufficiently practical apparatus, it was a very simple matter to substitute such a motor, properly protected from the danger of ignition of gas by the enclosure of all parts within an iron case.



DISC COAL CUTTER AT WORK.
Courtesy of the Diamond Coal-Cutter Co.

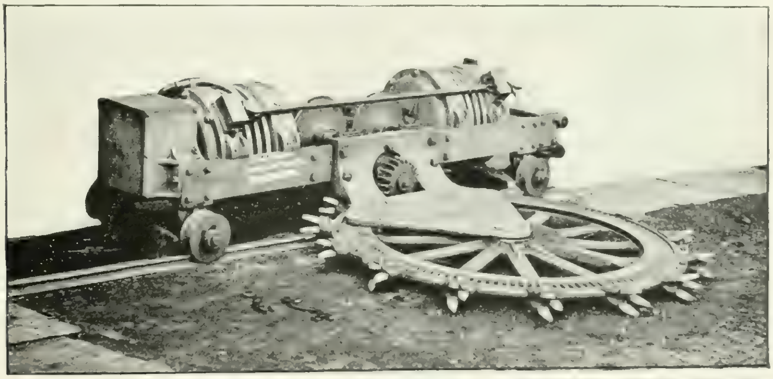
The coal-cutting machine is placed longitudinally in front of one end of a long face or wall of coal, previously prepared, the machine being on rails laid for it, and the haulage rope taken out and secured at the end of the face. The cutting disc lies very close to the ground, and when first fixed a place is cut for it by hand to the depth under the coal of nearly half its own diameter. When everything is ready current is allowed to pass into the motor coils, the disc revolves, cutting the channel under the coal, and being pulled forward as it cuts by its own haulage drum. As the electric motor runs at a much higher speed than the engines it displaces, gearing has to be arranged between the shaft of the motor and the axle of the disc; but there is plenty of room for this, owing to the displacement of connecting and eccentric



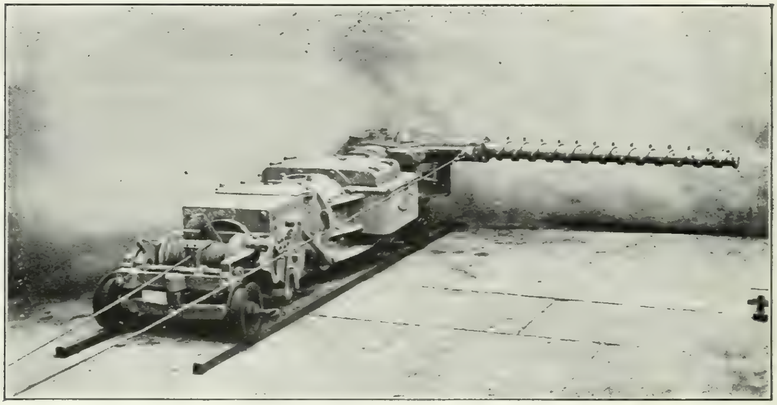
COAL-CUTTING MACHINE WORKED BY TWO THREE PHASE MOTORS, ONE EACH SIDE OF THE CUTTER DISC.
By the Diamond Coal-Cutter Co.

rods, etc. The gearing is contained principally within the iron box, and consists either of a train of wheels, or worm and wheel, the axle of the motor being geared to one end of the train and that of the disc to the other end.

Another form of coal-cutting machine which has been introduced by the electrical firms who have taken the matter up, and which has not I believe, been driven by any other physical agent, is the bar coal-cutter, shown on page 720. In this machine a bar, slightly tapering outwards, takes the place of the disc, movable cutters being placed in circles round the bar. There are two forms of this coal-cutter, one known as Goolden's, in which the bar is held rigidly when it has once assumed the position perpendicular to the coal face; the other, known



DIAMOND COAL-CUTTER DRIVEN BY TWO CONTINUOUS-CURRENT MOTORS, ONE ON EACH SIDE OF THE CUTTER DISC.

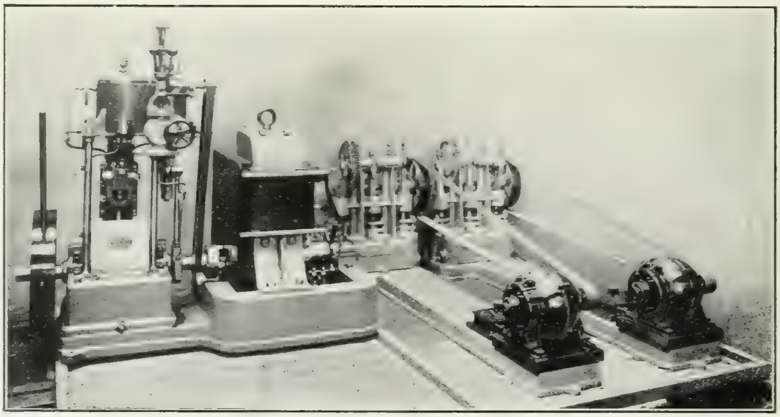


HURD'S ELECTRIC COAL CUTTER.

A taper bar is used, provided with moveable steel cutters. By Mavor & Coulson, Ltd.

as Hurd's, in which the bar is able to ride up, if it meets with a piece of very hard rock, which the power at the disposal of the motor will not enable it to cut through.

Two other forms of electric coal-cutting machines are known in Great Britain—the Jeffrey chain cutter, and the Jeffrey coal shearer. In the chain cutter, which is principally used for driving headings, an endless chain with cutters attached works round a long frame, and receives motion through gearing from an electric motor carried on the frame. The front of the machine with the chain is pushed up against



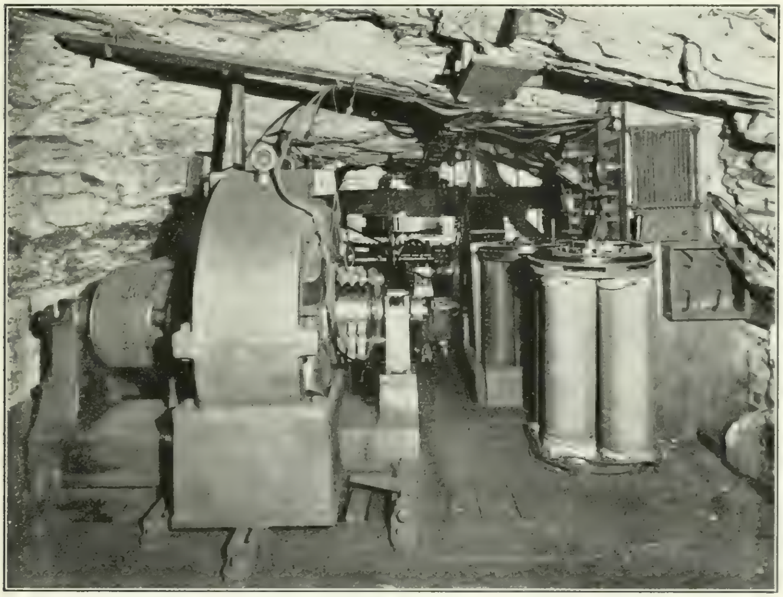
ELECTRIC PUMPING OUTFIT FOR NORTH OF ENGLAND COLLIERY, CONSISTING OF ENGINE DIRECTLY COUPLED TO DYNAMO, WITH TWO SETS OF THREE-THROW PUMPS BELT-DRIVEN FROM THE MOTORS.

By Ernest Scott & Mountain.

the face to be cut, and the chain works round, cutting as it goes, the frame following the cut as it is made.

A modification of this chain cutter is the bar cutter, in which a bar fitted with moveable cutters is held in a horizontal position, in front of the frame, parallel with the coal face, and revolves horizontally, cutting as it revolves, the frame following it. The shearing machine is virtually the horizontal chain cutter arranged to cut vertically instead of horizontally. It is also arranged to cut at different levels, so that a continuous cut of several feet may be obtained.

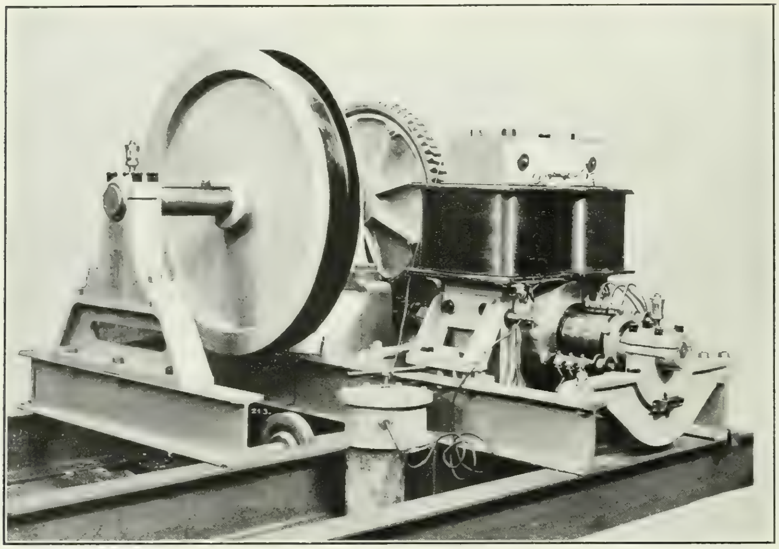
The iron box containing the electric motor in all coal-cutting machines also carries the switching and starting gear.



UNDERGROUND ELECTRIC HAULAGE POWER STATION FOR ENDLESS ROPE AT ACKTON HALL COLLIERY ; SHOWING STARTING GEAR, RESISTANCES, ETC.

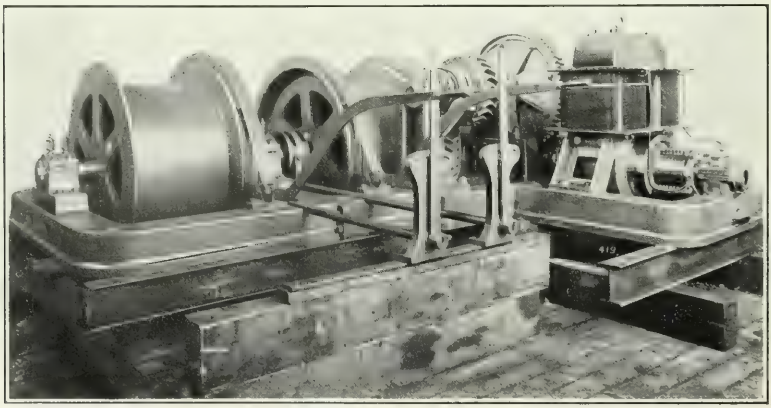
The motors of coal-cutting machines are fed from the electrical service of the colliery by means of cables brought to a convenient point, where a connecting box is usually fixed, and flexible cables lead from it to the machine, lights being taken from the same service. In a few cases, special generating plant has been put down for coal cutting only.

Coal cutting by electricity has not found as great favour in the United Kingdom as in America and on the Continent, and principally, I believe, because the pioneers in the work very much underestimated



ENDLESS-ROPE HAULAGE GEAR WITH ONE ROPE PULLEY, DRIVEN BY ELECTRIC MOTOR THROUGH WORM GEARING.

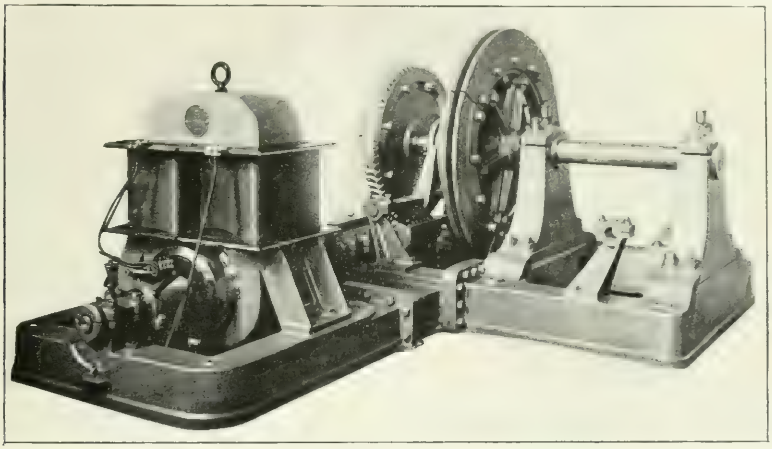
the amount of power required. Further, the motor used to drive a coal-cutting machine stands at a considerable disadvantage with reference to the engine using steam or compressed air, from the fact that, in the event of the cutter sticking fast, considerable damage may be done to the electric motor by its coils heating, where the engines would suffer no inconvenience beyond the stoppage. The remedy, of course, is the use of larger and more powerful motors. The power required for operating a coal-cutting machine varies necessarily with the



ELECTRIC MAIN-AND-TAIL HAULAGE PLANT, DRIVEN THROUGH GEARING.

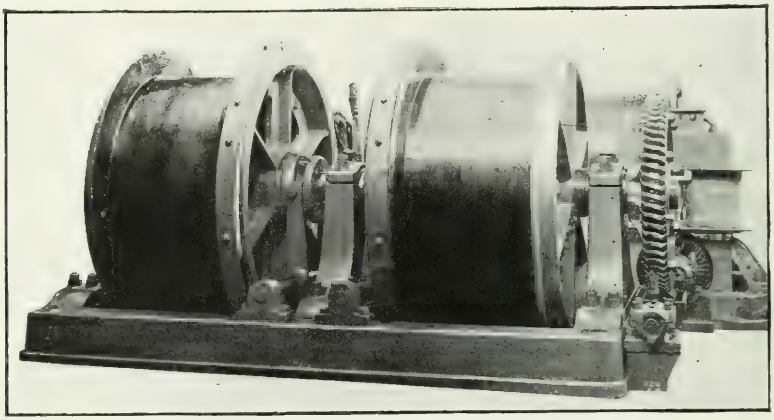
hardness of the coal or rock to be worked. For some of the softer coal seams, as little as 12 horse power is sufficient, while in other cases as much as 30 horse power may be required, and even 50 horse power has been provided in some cases. These powers are delivered to the motor, and include the charge for conversion within the motor itself and for gearing, but not that for the loss in the cables leading from the generators. The current strength required will be inversely in proportion to the pressure delivered at the motor.

Mine haulage in Great Britain, with a few exceptions and with occasional modifications, is arranged on one of two principles—the endless-rope or endless-chain system, and the main-and-tail system. In the former, as the name suggests, the rope runs from the driving engine out along one set of rails, around a pulley at the extreme end, and back along the other set of rails. Loaded trams coming from the mine, or empty ones going in, are attached to it at any desired point by a suitable form of clip. The travel of the rope is continuous, motion being imparted to it either by a clip pulley or a friction pulley, which under the old steam practice was usually placed on the crank shaft of a pair of engines. All that was necessary to convert an endless-rope hauling engine to an electrical hauling engine was the substitution of an electric motor with the necessary worm or wheel gearing for the pair of engines, the pinion on the axle of the motor engaging as before, with the last wheel of the train, or the axle carrying the worm.



ELECTRIC-DRIVEN ENDLESS-ROPE HAULAGE GEAR, WITH CLIP PULLEY.
By Ernest Scott & Mountain.

In the main-and-tail haulage system usually only one set of rails is provided, and the same rope brings the full trams out from the coal face to the pit bottom and returns the empty trams to the face. The rope, though in one, is really two ropes formed into one, *viz.,* a main rope which pulls the full trams out, and a tail rope which tails after the full trams, and which then becomes the haulage rope to pull out the empty trams. The main and tail ropes are wound in, each onto its own drum, which drums—before the advent of the electric motor—were usually driven by means of a pair of engines and gearing. With electric main-and-tail haulage, motion is communicated to the drums by means of the electric motor and gearing, the axle of the motor, as before, carrying the worm, or the pinion which engages with the last of the train; or the motion may be communicated from the axle of the motor, by means of a belt or ropes, to a first motion shaft, and from thence to the haulage drums. This last method has the great advantage that it relieves the armature of the motor of the heavy initial strains on starting. With electrical haulage, whether endless-rope, or main-and-tail, one essential difference from the engine-driven haulage is necessary, *viz.,* the switchboard.


MAIN-AND-TAIL HAULAGE GEAR, ELECTRICALLY DRIVEN THROUGH WORM GEARING.

There are various modifications of these two systems of haulage, arranged to suit the special arrangements of different mines, but the arrangement for the adoption of electric motors in place of steam or compressed-air engines remains the same.

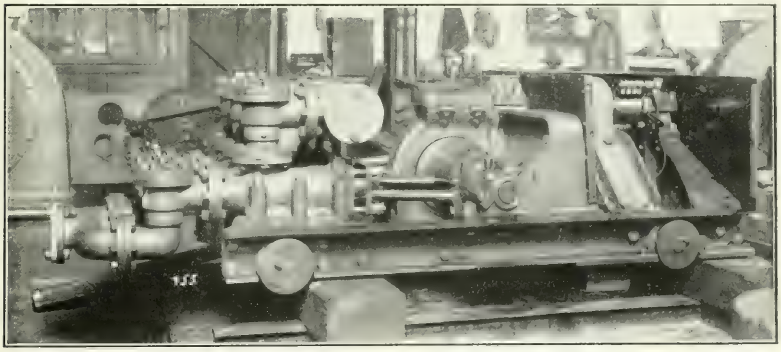
Secondary Haulage.—Where the mine is large, the area of the lease being extensive, and the endless-rope system largely employed, what is termed secondary haulage is also used. Out of the main engine road branch several smaller roads leading to the coal face, and it is from these smaller roads that the endless rope on the main-engine plane is fed.

In a great many mines the secondary haulage is worked by ropes driven by pulleys, which are again driven by the main haulage rope, a mechanical clutch giving command of the gear. In some cases, however, electric motors have taken their natural place, and are used to work these secondary haulage roads.

There is another form of electric haulage, very much used in mines on the continent of Europe, in which an electric locomotive hauls a journey of trams from the face of the coal. The locomotive is worked by means of a current obtained from an overhead trolley wire, being merely a truck carrying a motor, starting and stopping gear, and measuring instruments. I believe that this system is used almost entirely on what are termed "levels" in Great Britain, in which the mine consists of a tunnel running into the side of a hill. The electric locomotive haulage has been in use in the Laukeroda mine in Prussia for nearly twenty years past, an angle iron on the side of the tunnel taking the place of the trolley wire.

Pumping by Electricity.—The water in the mine may be dealt with in two ways, according to how the coal beds lie.

Where the coal dips from the shaft, the face of the coal will be the lowest part of the mine, and any water there may be in the mine will gravitate there.



HORIZONTAL THREE-THROW PUMP, WITH ELECTRIC MOTOR MOUNTED ON SAME CARRIAGE, FOR USE IN DIP WORKINGS.

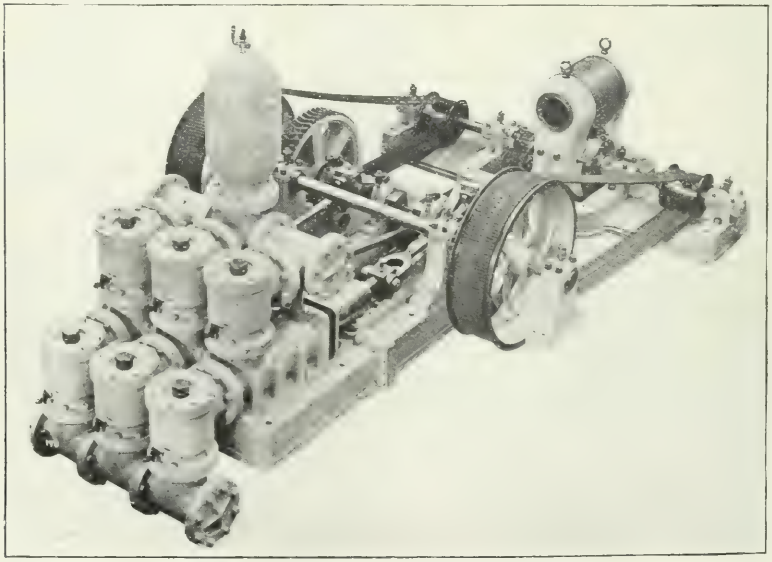
By Ernest Scott & Mountain.

As the face of the coal is constantly moving onward, and downward, the water following it, the pump and electric motor are usually mounted on one carriage, of wood or iron, on which are also mounted drums for the cables and the switching and starting gear. The carriage or truck is placed on wheels, mounted on the rails, and follows the face and the water as it advances.

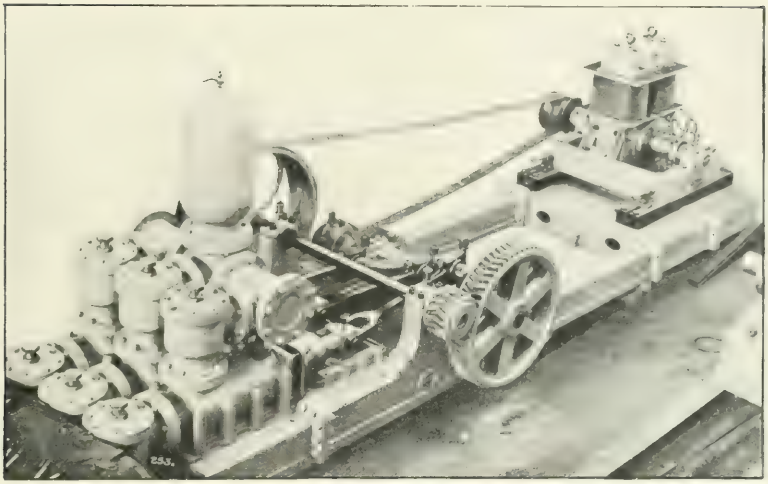
The other method of dealing with the water in a mine is to allow it to drain into tanks or chambers, either at the pit bottom or at various portions of the mine, and at these stations placing a pump and motor of the size required. In these cases a chamber is formed in the coal, lined with timber or brick, and in it the pump, motor, and switching gear are placed, the pump and motor now being fixed on firm foundations and the switchboard on one of the walls of the chamber.

The power required to be delivered to the motor working an electric pump necessarily varies with the quantity of water raised, the height it has to be forced, and the length of pipes through which it is forced.

One very beautiful adaptation of electricity for mine pumping, which is also of great service for other purposes, is the ability to stop or start the pump without anyone going near it. It often happens that a pump is placed either in an out-of-the-way spot, or at some distance, while it may be required to work only a few hours, more or less, each day, according to the water present, and it is desired to avoid the expense of having an attendant there constantly. Also, if a pump is left by itself, some of its bearings or those of the motor may get hot, causing so much extra friction that the motor cannot overcome it, and stops, possibly being seriously damaged in the process.



THREE-THROW RAM PUMP FOR DIP WORKINGS, BELT-DRIVEN BY ELECTRIC MOTOR, THE WHOLE MOUNTED ON ONE BED PLATE.



ELECTRIC DIP PUMP ON CARRIAGE, WITH BELT AND WHEEL GEARING.
By Ernest Scott & Mountain.

To avoid this an apparatus very much like an old telegraphic relay is employed. It consists of an electro-magnet of the usual form, whose coils are included in the circuit supplying current to the pump motor. The armature, when the pump is working normally, occupies a certain position. If from a hot bearing or any other cause the motor stops, instantly the armature is attracted to the poles of the magnet, and completes a local circuit which throws open the pump switch. For the reverse operation, when the pump has no work to do, all the water having been pumped out, or the equivalent, and the motor is running away, the current passing to the pump being so weakened the armature falls back, again completing a circuit which opens the pump switch.

THE FUTURE OF POWER DEVELOPMENT.

By William D. Ennis.

MR. GEORGE WESTINGHOUSE was probably the first to formulate the theory that more saleable energy results from an electric-generating plant in which the dynamos are driven by gas engines, than from one in which the motive power is steam, resulting from a combustion of the same amount of coal requisite to produce the gas consumed in the former case. Mr. Alton D. Adams, writing in the April number of THE ENGINEERING MAGAZINE, demonstrates that a producer-gas plant having a combined efficiency of 20 per cent. will show a saving of 39.4 per cent. of the coal required for a highly economical steam-driven plant carrying the same load.

The reciprocating steam engine, of which the fundamental formula was deduced by Carnot, represents the mechanical progress of a century, and exemplifies in its history the beginnings of scientific engineering. In Professor Thurston's recent paper,* read before the American Society of Mechanical Engineers, a *résumé* of this history is given, showing from what small beginnings have been developed the almost universal prime mover of to-day, with its efficiency only 16 per cent. short of that of the ideally perfect engine of its class. It might be expected that the author of this monograph, after having so aptly described a century of progress, would be justified in indulging in some words of gratification. What the writer does say, however, is as follows: " . . . the field of the steam engine will become greatly restricted by the introduction of other heat motors . . . by the employment of electricity . . . from hydraulic and pneumatic prime movers. The steam engine has now been so far perfected . . . that but little more can be expected of the designer; and even with the costlier types of engine . . . commercially practicable progress seems likely to prove very slow henceforth."

Every method of obtaining power depends on a series of transformations applied to some material or force supplied by nature. One of the simplest of these series is in the case of a wheel turning by the force of a waterfall. In an electric steam-driven power plant, we have: (1) Combustion of the coal, (2) evaporation of water into steam, (3) expansion of steam in a closed cylinder, causing a straight-line motion of a moveable piston, (4) transformation from a straight line to a rotative motion, (5) generation of electrical currents due to this rotative motion of conductors in a magnetic field—or five transformations in all. In a producer-gas-driven plant of the same kind, there are two initial series of transformations, culminating in one result. The auxiliary series consists of: (1) Coal combustion, (2) evaporation; and at this point is joined to the main series, after its first step. The main series is (1) moderate heating of coal, (2) combination with the component gases of steam, (3) (neglecting enriching processes), ignition and explosion, (4) rotary motion, (5) generation of current. The number of transformations in the main series is five, in the auxiliary series two. The furnace coal is an item of much more consequence than the boiler coal from a financial standpoint, and the additional auxiliary item may be ignored in comparison, so that the total number of changes is practically five, the same as in the case of a steam-driven plant.

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* Trans. A. S. M. E., No. 833, Vol. XXI.

From a purely theoretical standpoint, assuming that all transformations are equally efficient, gas possesses no superiority over steam. The general equation for resultant efficiency of any motive force is x^a, where x is the efficiency of each transformation, and ^{a} is the number of transformations. For this reason, a turbine-driven dynamo will give a greater pro-rata output than one steam driven, in the ratio of x^2 to x^5. Moreover, even when the varying values of x are considered, it is obvious that the gas-driven plant, with its exponent of ^{5}, can never compete with a hydraulic plant having an exponent of ^{2}.

Obviously, the only method of increasing the output in any given series is to increase the value of x (which is always less than unity), or to decrease the value of ^{a} by eliminating one or more steps from the process. In the case of a steam engine, driving an electrical generator, assuming the efficiencies of the various steps in the series to be 0.80, 0.9375, 0.15, 0.90, and 0.95, respectively, the value of x^a is equal to their product, or 0.096—less than one-tenth of the initial coal energy being utilized. The value of ^{a} cannot be diminished, and that of x is capable of only a limited increase. The utmost attainable values of the factors above given are probably 1.00, 1.00, 0.35, 1.00, and 1.00, the product being 0.35, which is the ideal value of x^a. An attainable output equal to over one-third the coal energy would result, or over three times the output under present conditions.

In a gas engine, the Carnot cycle, with an efficiency of possibly 0.35 under conceivable ranges of pressure and temperature, is generally replaced by the cycle of Beau de Rochas. This is applicable to internal-combustion motors only, and gives but one impetus to the piston in every four strokes. Pressures of more than 300 pounds to the square inch are met with, which gives an advantage, both theoretical and practical, over the ordinary steam engine. Thermal efficiencies, from gas to electrical output, of 13 per cent.* are reported even for engines as small as 125 horse power. For larger units, 20 to 25 per cent. efficiency is claimed.†

No comparison between the steam engine and the gas engine is just which does not take into account all the transformations, from raw material to finished product. It is true that a manufacturer may frequently be ignorant of the cost of the raw materials of his trade, those materials reaching him in a partially completed form. If we know the cost of steam and the cost of gas, it appears a simple matter of arithmetic to determine the most economical form of power. Unfortunately, we do not know the cost of steam, nor of gas, in a scientific and accurate way. For every case, these costs differ; and in every case there is some factor in their production that is not manifest in the statement of that cost, but which may yet have an important bearing on the remaining transformations and on the final value of x^a.

An expert, in analyzing such costs, would probably group them about general headings like the following:

INVESTMENT (A).

THE STEAM ENGINE.	THE GAS ENGINE.
Real Estate.	Real Estate.
Buildings.	Buildings.
Boilers.	Boilers.
Boiler Setting.	Boiler Setting.
Flue and Stack.	Flue and Stack.
Piping.	Piping.
Auxiliary Machinery.	Retorts.
Engines.	Holders.
Condensers.	Gas Piping.
	Auxiliary Boiler Machinery.
	Auxiliary Gas Making Appliances.
	Gas Engines.
	Mufflers, etc.

OPERATION (B).

Coal for Boilers.	Coal for Boilers.
Water for Boilers.	Water for Boilers.
Oil.	Oil.
Water for Condensers.	Cooling Water for Engines.
Labor.	Coal for Retorts.
	Naphtha, etc.
	Labor.

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* Trans. A. S. M. E., No. 835, Vol. XXI.

† THE ENGINEERING MAGAZINE, April, 1900

GENERAL OPERATING EXPENSES. (C).

Interest.
Sinking Fund (Depreciation).
Taxes and Insurance.
Superintendence and Expense.

Added to these factors there are several others, not to be shown on a balance sheet, but of overwhelming importance as governing the final answer to the question of form of power. Some of these will suggest themselves at once.

(1) Safety.

(2) Continuity of service.

(3) Effect on public health and comfort.

(4) Applicability to varying loads and conditions of load.

(5) Effect of location—whether near a central source of supply of steam or gas, or isolated.

Speaking generally, there are to be considered two great factors influencing the costs. The first is location; the second, size of plant. Two conditions are possible, with regard to location; nearness to, or remoteness from, a central supply. The sizes may be distinguished as small, medium, and large. No further exactness is possible, nor can we tell just what capacity limits are covered by these three terms.

First, assume the existence of a plant to be close to a central station. The steam user, whether he be in the small, medium, or large class, will in all probability have his own boilers in preference to buying steam. The gas-engine man, if a small consumer, will buy. For him, A will be proportionately large, and B likewise. He will gain little, if any, in efficiency over the steam user, and will be dependent upon a single outsider for the operation of his plant. If a moderately large consumer, he will be able to buy gas at low rates, but unless the conditions are extremely favorable he will be handicapped in competition with steam by the high cost of his equipment and the consequent high interest charge. If a very large consumer, he will have his own gas-making plant, or will buy gas at an equivalent rate, so that he will obtain the unquestioned advantage of a higher efficiency.

Where the plants are at a distance from a central supply, the small gas man may have a miniature producer, but his first costs and interest charges will be enormous. The larger consumers will pay proportionately less on these accounts, but will have a large and complicated equipment to care for.

In all these instances, there are suggested certain limitations and modifications. First, gas making, even fuel-gas making, is a special process, requiring great skill. This militates against the small consumer in the country. Second, gas from a central station must be carried to the consumer in expensive pipes. This is of consequence to the buyer of gas, be his requirements large or small. Third, the gas engine furnishes no exhaust steam for heating a building during the months when heating is required and the power load is most ample to take care of the heating. This is a point in favor of steam for small city consumers.

As Mr. Westinghouse has pointed out, the relations of this subject with those of garbage disposal and water supply* are of the utmost consequence. It seems reasonable to expect that these relations will result in an immense field for gas in large central power stations at some future time. It is no less reasonable to suppose that the gas engine will have a wide and increasing field of its own aside from these peculiarly favorable conditions. Both steam and gas have other competitors, which, however superior from the x^a point of view, are so limited as to location and size as to be only locally formidable.

I see no reason to believe that steam will be superseded to any great extent by any of the prime movers above mentioned. In fact, there will always remain certain locations and conditions which will absolutely debar gas or hydraulic sources from consideration. The problem before the steam engineer in the next century is that of getting away from the Carnot cycle and its limitations. We have the steam turbine or reaction motor, with an economy, in its infancy, of 16.4 pounds of steam per indicated horse power per hour. Better things than this will come.

Far better results than this will be demanded before the close of another century of progress. Civilization will not be content with a force obtained through five transformations from the natural material, when even at this time such force is obtained through one or two such transformations in the laboratory. By the close of the years beginning with the figures 19—, the question of exhaustion of the world's coal supply will be more than once considered. The power of the future will be obtained by methods of decomposition and synthesis, simple beyond conception in comparison with those known at present. Such a culmination will reduce to a common plane all of the five-transformation powers of to-day; but the outlook for the steam engine from our present standpoint is toward a perfection of mechanism, a standardization of types for recognized lines of work, leaving to gas, water, and the other forces the development of enterprises unusual in nature or in magnitude.

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* *Journal of Electricity,* March, 1900, p. 47.

HEAVY MOTOR VEHICLES FOR ROAD SERVICE.

By Fred M. Maynard.

UNTIL within recent years, horse haulage, rivers, canals, and railways have been the only available systems of carriage between our various cities, towns and hamlets, each system having its own particular field of employment.

Horse haulage, which from time immemorial has provided a most satisfactory means for independent travel, is now found, for many purposes, to fall far short of present-day requirements. Its high cost and slow rate of progression when employed for heavy loads militate against its use from a commercial point of view, while hygienic considerations distinctly condemn its employment in crowded cities and towns on account of its unsanitary features.

Rivers and canals, although affording the cheapest system of carriage between fixed points, have three great drawbacks, namely: The length of time goods are in transit; the unloading from a vehicle into a barge or boat and vice versa at the end of the water journey; and lastly, availability only at places situated on such water ways.

Railways must always prove the cheapest medium for rapid transport over long distances, but below 40 miles the terminal charges are so great in proportion to the cost of haulage that promising scope is afforded to any system of road carriage that can by one straightforward journey dispense with such terminal charges.

Thus has it been gradually recognised that an enormous field exists for an intermediate form of transport, which, while independent of fixed routes, should possess greater latitude, and shew in use economy superior to that of the horse.

The traction engine partially fulfills these conditions, but the one great objection to its employment is that its full economy can be secured only when, comparatively speaking, very heavy loads are dealt with. This objection, however, does not hold good with the auto-waggon, which provides just that rapid and cheap form of independent direct transport for which so great a need exists at the present day.

The motor vehicle has practically established itself as the latest mechanical development of the century. In its lighter forms, it has become so common in the larger cities as no longer to attract attention. For heavier service—in which it seems destined to play even a larger part—progress is to be made solely by proof of greater economy and convenience. Mr. Maynard's actual comparisons of installation and working costs are therefore of great value. A second paper, in the next issue of this Magazine, will discuss and illustrate the specific forms which have become prominent in Great Britain. THE EDITORS.

Apart from the pecuniary saving, the benefits following in the train of the general adoption of motor traction cannot be over-estimated. The incalculable boon of cleaner streets, in point of view of the public health, should rank almost before economy, for it has long been a well-recognised fact among medical men that many epidemics, and also that fatal disease, tetanus, are in a very large measure due to the air of our streets forming a medium of suspension for germs which originally find a breeding bed in the predominating portion of the dirt caused by horse traffic in dry weather.

But with cleaner streets the cost of scavenging will be enormously reduced, and, owing to the absence of that pulverising action of the horses' hoofs, a corresponding saving in the expenditure for maintenance and repairs of the road surfaces will be the natural result.

Further, by the banishment of horses from the roadways of our cities, those terrible stone setts and cobbles, now compulsory on those routes traversed by heavy freight-carrying vehicles, would be no longer needed, but the extended use of asphalt or other silent road covering would be rendered not only possible, but necessary to obviate the excessive jarring of the motor vehicles and their machinery, thereby increasing their life, which could be still further augmented by the general employment of rubber and pneumatic tyres; such abrading and puncturing agents as flints and the like being conspicuous by their absence. An asphalt road requires only a water hose to keep it scrupulously clean. Another indirect benefit would be that with such silent rubber-tyred vehicles the continual clatter of street traffic, so harassing to the nerves of the city man, would be abolished.

As it is in its essentially commercial aspect only that the subject of motor haulage will be regarded by business men, on no better lines can the question, "Which is the cheaper form of transport?" be answered than by applying Lord Kelvin's rigorously accurate "Law of Economy" for its solution. This law tells us that "the most economical working is effected when the interest on the increment of capital is equal to the saving in annual expenses effected by such increment."

To reduce this to practice, it is necessary carefully to consider the cost of the various forms of carriage.

According to effects, the standard of work a horse is capable of performing is 14 nett ton miles in a day on ordinary roads, while two horses harnessed to one waggon may achieve 35 nett ton miles daily in regular work; or, to put it in other words, two horses will draw a nett load of 3 tons at an average speed of 2 miles per hour for 6 hours $= 3 \times 2 \times 6 =$ nett ton miles.

The prime cost of a two-horse waggon will probably be:

	£	s.	d.
One 3-ton lurry	60	00	00
Two horses at £50.0.0	100	00	00
Two sets harness, etc., at £7.10.0	15	00	00
	175	00	00

Working expenses per annum:

	£	s.	d.
Interest, 5 per cent	8	15	00
Depreciation, 15 per cent	26	5	00
Fodder and bedding at 12s. per week	62	8	00
Insurance, 2 per cent	1	15	00
Repairs to dray, harness, etc	8	00	00
Shoeing at 1s. 6d. per week each	7	16	00
Horsekeeper (share)	13	00	00
Veterinary surgeon	2	2	00
Rent, rates and taxes	13	00	00
Driver	65	00	00
	208	1	00

The prime cost of a commercially reliable steam dray carrying a maximum load of 3 tons is £652.10.0.

The annual working costs of such a dray will be as follows:

	£	s.	d.
Interest, 5 per cent	32	12	6
Depreciation, 15 per cent	97	17	6
Insurance	10	18	00
Repairs (approximately)	30	00	00
Rent, rates and taxes	5	5	00
Fuel, 8.88 pounds anthracite coal per vehicle mile, × 12 × 260 = 12 tons, 8 cwt. at 20s	12	8	00
Coal for raising steam	6	10	00
Wood for lighting fire		15	00
Water, 7.15 gallons per vehicle mile, × 12 × 260 = 22,308 gallons at 1s. per 1,000	1	2	4
Driver's wages at 35s. per week	91	00	00
Lubricating oil and waste	3	10	00
	291	18	4

In this case the interest on the increment of capital is (£652.10.0 — £175 = £477.10.0 at 5 per cent. =) £231.8.0, but the annual working expenses of the steam dray exceed this by £59.19.4 (£83.17.4 — £23.18.0 = £59.19.4); so that evidently it will not pay to substitute an auto-waggon for a horse-drawn one where so little hauling is required.

The daily work of a steam dray is at least 3 tons carried at the rate of 5 miles an hour for, say, ten hours, or 3 × 5 × 10 = 150 nett ton miles, giving in the year of 260 working days 150 × 260 = 39,000 nett ton miles. Now, as by the previous example it is seen that one two-horse dray can deal with only 36 nett ton miles per day, it will be evident that 150 nett ton miles will require 150 ÷ 36 = 4.3 two-horse units, or, say, 9 horses and 4 waggons, the cost working out as follows:

	£	s.	d.
Four 3-ton waggons, at £60	240	00	00
Nine strong horses, at £70	630	00	00
Nine sets harness, rigs, etc., at £7.10.0	67	10	00
	937	10	00

Annual working expenses:

	£	s.	d.
Interest, at 5 per cent. on £937.10.0	46	17	6
Depreciation, 15 per cent	140	12	6
Fodder and bedding, at 12s. week each	280	16	00
Shoeing at 1s. 6d. per week each	35	2	00
Repairs to waggons, harness, etc	36	00	00
Insurance, at 2 per cent	18	15	00
Horsekeeper (ostler) at 25s	65	00	00
Veterinary surgeon	9	9	00
Rent, rates and taxes	78	00	00
Four drivers, at 25s. per week	260	00	00
	970	12	00

The fixed annual charges for the motor waggon will be the same as in the previous example, but the running cost will be somewhat larger, and is as follows:

Fixed charges:	£	s.	d.
Interest, 5 per cent	32	12	6
Depreciation, 15 per cent	97	17	6
Running costs:			
Insurance, 2 per cent	13	1	00
Repairs (estimated)	100	00	00
Rent, rates and taxes	5	5	00
Fuel, 8.88 ℔s. anthracite coal per vehicle mile, × 50 × 260 = 51.54 tons at 20s	51	10	10
Coal for raising steam	6	10	00
Wood for lighting fire		15	00
Water, 7.15 gallons per vehicle mile, × 50 × 260 = 92,950 gallons at 1s. per 1,000	4	13	00
Lubricating oil and waste	12	00	00
Wages driver, at 35s. per week	91	00	00
	415	4	10

Comparison of costs:

	£	s.	d.
Horse drays	970	12	00
Steam drays	415	4	10
Annual saving	555	7	2

In this case, in place of an increment of capital being necessary, a substantial reduction in prime cost is effected and a maximum economy is secured. From the two examples it will be easy for anyone interested to work out for himself whether the adoption of a motor dray will prove a pecuniary benefit to him or not, and to what extent.

Saving on Railway Rates (from actual figures).—The railway rate between two towns 11 miles apart for a certain class of goods is 4s. 6d. per ton, and the total weekly load to be moved in both directions was 100 tons, the annual cost for which was 100 × 4s. 6d. × 52 = £1,170.0.0. It was found, however, that by employing a steam dray and trailing vehicle, two loads of 5 tons in each direction, or a total of 20 tons, could be carried in a day five days in the week, at a cost of £646.2.4, shewing a saving as follows:

	£	s.	d.
Railway charge	1,170	00	00
Steam road haulage	646	2	4
Annual saving	523	19	8

At the same time the goods were delivered at their destination much more quickly, and all handling at the depots at either end of railway journey was dispensed with.

Saving on Canal Rates.—The mill of a large Manchester cotton firm is situated in a town 18 miles from that city, and their traffic, which had been carried by canal between the two places, amounted to 50 tons per week, the freight on which was 6s. 8d. per ton, giving a yearly cost of £866.13.4 for canal carriage (which necessitated horse delivery in Manchester). By the adoption of a steam waggon and trailer, a full load of 5 tons being carried into Manchester twice a day, the whole of their traffic was dealt with in five days a week; the cost being as follows:

	£	s.	d.
Prime cost of steam waggon and trailer	697	10	00

Working costs of same per annum:	£	s.	d.
Interest, 5 per cent	34	17	6
Depreciation, 15 per cent	104	12	6
Insurance, 2 per cent	13	19	00
Rent, rates and taxes	7	7	00
Repairs (estimated)	125	00	00
Fuel, 9.37 ℔s. coal per vehicle mile, *loaded*, = 36 × 9.37 × 260 = 39 tons 3 hundredweight at 20s. per ton =	39	3	00
Fuel, 7.02 ℔s. coal per vehicle mile, *light*, = 36 × 7.02 × 260 = 29 tons 7 hundredweight at 20s. per ton =	29	7	00
Coal for raising steam	8	2	6
Wood for lighting fire		15	00
Water, 7.37 gallons per vehicle mile, *loaded*, = 36 × 7.37 × 260 = 68,983 gallons at 1s. per 1,000 =	3	9	00
Water, 5.52 gallons per vehicle mile, *light*, = 36 × 5.52 × 260 = 19,872 gallons at 1s. per 1,000 =	1	00	00
Oil and waste (stores)	13	10	00
Drivers, two, at 35s. per week each	182	00	00
Brakesman for trailer, at 20s	52	00	00
Total	615	2	6

Comparison of costs:

	£	s.	d.
By canal	866	13	4
Auto-waggon	615	2	6
Annual saving	251	10	10

This is an example in which a *full* load could be secured only *one* way, yet even with this a saving was secured of no less than 28¾ per cent. upon what has always been looked upon as the very cheapest form of transport; the goods being delivered in a much shorter space of time, and transshipment from barge to lurry in Manchester being entirely obviated. Naturally, had it been possible to arrange for a return load, the gain would have been greater by the value of that extra carriage, less running expenses, fuel, water and stores.

The foregoing examples clearly demonstrate that the auto-waggon is within certain limits undoubtedly the most economical of all systems of land carriage.

Among the various sources of energy suggested for the propulson of these heavy automobiles we have electricity, compressed air, petroleum, and steam.

Electric motors are clean, extremely convenient and simple, free from all vibration and danger, and altogether an ideal type of motor; but for freight-carrying waggons to run 40 miles without recharging, electricity appears at the present time impracticable; the great dead weight of the accumulators necessary to store the requisite energy being apparently an insuperable difficulty, especially where a fairly heavy useful load is required to be carried. Their high cost and short life also greatly militate against their use for heavy-vehicle propulsion, as in this service disintegration naturally takes place much more rapidly than in a stationary battery, owing to the vibration over rough roads.

Compressed air would, at first sight, seem to fulfill all requirements, owing to an entire absence of the waste products of combustion and the absolutely innocuous exhaust from the motor. Both in America and France much time and money are being expended in experimenting, with a view to perfecting this ideal source of energy. Naturally, the factors which govern its suitability for the purpose are, first, its safety, this being based upon the means adopted for its storage, and second, its economy, which is dependent partly upon the total useful load it is possible to carry on a vehicle of a given tare weight, inclusive of the charged air cylinders. For universal use, however, there would appear to be certain objections to this system; in the first place, an air-compressing plant would be essential, and it would certainly not pay a user to erect such a plant for the exclusive supply of one or two vehicles, while, when a central supply has to be relied upon, the "independence" of the motor vehicle is at once sacrificed.

Oil (or more correctly, petrol) motor waggons of the German

Daimler type have shown themselves both reliable and economical in running, but dependent as they are on the employment of a light mineral spirit, which is not universally obtainable, and being somewhat delicate and complicated in construction, they are not exactly suited for regular heavy work; another great objection to their use being that variation of speed is almost entirely dependent upon gearing, there being no elasticity in the oil motor as in the steam engine.

This, therefore, brings us to the consideration of steam, which is generally admitted to be the only suitable means of propulsion at the present day for heavy motor vehicles, combining as it does the great essentials of independent running (fuel and water being obtainable where no other sources of energy are to be found), great reliability, simplicity, economy, and flexibility.

The boiler for use on an automobile must needs be small, light, of great strength, and capable of quickly making steam at the right pressure and in sufficient quantity. Further, it is necessary that it should be constructed of material and to a design that will pass the recognised boiler authorities. Unfortunately, many of the steam generators at present in use are built without any such official inspection or testing; they are very light in construction, offer a small factor of safety, and have but little endurance.

The three types of generators at present employed on various vehicles are the water-tube, fire-tube, and flashing or "waterless" boiler. Among the first named may be mentioned the Thorneycroft, as designed by this celebrated firm for use on their torpedo boats, the Merryweather, originally employed on steam fire engines, and the French de Dion et Bouton, which, however, is very heavy and not easily accessible; as a class the water-tube is distinctly the most efficient and the safest, although somewhat more costly than either of the other types.

The only English fire-tube automobile boiler of any note is the Leyland; this is a vertical generator, simple in construction, with tubes of less diameter at the top than at the bottom. It gives fairly satisfactory results in use.

Modifications of the original Serpollet flash boiler have been adopted in the steam drays of Simpson and Bodman, of Manchester, and Musker, of Liverpool. The advocates of this type of generator put forward very specious arguments in its favour, but so far, with the exception of the Serpollet, they are yet in their experimental stage only, none having passed through the searching test of actual lengthened road service; among well-informed engineers, however, the apparent advantages of the system are heavily discounted, its inherent weaknesses being so many.

Although in one or two cases condensers are employed, the opinion of those competent to judge is that the great attendant disadvantages of increased cost, weight, and complication more than outweigh their nominal advantages, and that where water is obtainable at points not more than 15 miles apart a condenser is practically of very little value.

The steam motors employed are small and run at a high speed of revolution; both horizontal and vertical types are in use, and are generally of the two-stage, or triple-expansion pattern; in some instances the engines are only uni-direction. The necessity of high steam pressures to obtain a large power from these small motors will be at once apparent. Owing to the high speeds employed, ample bearing surfaces and automatic lubrication are two indispensable provisions.

The relative horse power for given loads is anything but uniform, and clearly shows why the cost prices of the vehicles under notice vary within such wide limits. While one firm gives an engine with an available horse power of 35 for a load of 3 tons, another will allow only 14 brake horse power for a load of nearly 4½ tons.

TRANSMISSION.—From the engine to the road wheels the power is usually transmitted by means of spur or bevel gearing to an intermediate or counter-shaft, and thence through differential gear and sprockets and chains to the driving wheels. In those cases where chains are dispensed with, plain spur or helical gearing is employed for the final drive. This involves a somewhat greater outlay, but it is more certain in action and is almost everlasting in wear. The renewal of worn-out driving chains, owing to their short life, forms a heavy item in the repair account of chain-driven heavy freight vehicles.

WEIGHT, DISTRIBUTION AND ADHESION.—The importance of placing as much as possible of the weight of the vehicle upon the driving axle is scarcely to be over-estimated, as otherwise the full propulsive effort of the engine cannot be effectively applied when the waggon is running light. This was very pointedly illustrated at the Liverpool hill-climbing trials last year, when the performances of some of the competing vehicles were curiously erratic, owing to the lack of appreciation on the part of the builders of this most important detail in their construction.

My second article will take up the specific forms of motor waggon which have proved successful in Great Britain.

EDITORIAL COMMENT

The fog which hides events in China is still so dense that, as we go to press, it is not yet possible to do more than guess vaguely at the actual state of affairs in Pekin. Hope has given way to fear that the horrifying reports of early July are only too well founded, based, it is to be feared, on facts which seem to grow even more hideous as they are more clearly seen.

But one thing is very certain: No matter what the immediate incident, the regeneration of China is under way, and the present months of struggle and agony are accomplishing what would otherwise have taken decades. As Mr. Foord puts it elsewhere in this issue, the new China is being born—*is* born already. There is a long period of anxiety still to be passed; the weakness of the child and the possible wrangles among its jealous protectors threaten protracted dangers; but so far the latter difficulty has been much less apparent than was to be feared—or even to be expected. If, as heretofore suggested in these pages, England, the United States, Germany, and Japan, are moved by an identity of aim and a unity of purpose in standing for the integrity of the empire and the open door, there is little fear of any extreme resistance.

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In one most important point the situation is clear, as it has never been before. This is in the official definition of the policy of the United States. The frank, positive, and definite declaration by the Secretary of State, sent in a circular telegram of instruction to the United States Ambassadors and Ministers throughout Europe and Asia, has not yet attracted the notice its importance demands. It is probably the most significant document issued by the present administration:

"In this critical posture of affairs in China it is deemed appropriate to define the attitude of the United States as far as present circumstances permit this to be done. We adhere to the policy initiated by us in 1857 of peace with the Chinese nation, of furtherance of lawful commerce, and of protection of lives and property of our citizens by all means guaranteed under extra-territorial treaty rights and by the law of nations. If wrong be done to our citizens, we propose to hold the responsible authorities to the uttermost accountability.

"We regard the condition at Pekin as one of virtual anarchy, whereby power and responsibility is practically devolved upon the local provincial authorities. So long as they are not in overt collusion with rebellion and use their power to protect foreign life and property, we regard them as representing the Chinese people, with whom we seek to remain in peace and friendship.

"The purpose of the President is, as it has been heretofore, to act concurrently with the other Powers, first, in opening up communication with Pekin and rescuing the American officials, missionaries, and other Americans who are in danger; secondly, in affording all possible protection everywhere in China to American life and property; thirdly, in guarding and protecting all legitimate American interests; and fourthly, in aiding to prevent a spread of the disorders to the other provinces of the empire and a recurrence of such disasters.

"It is, of course, too early to forecast the means of attaining this last result, but the policy of the Government of the United States is to seek a solution which may bring about permanent safety and peace in China, preserve Chinese territorial and administrative entity, protect all rights guaranteed to friendly Powers by treaty and in law, and safeguard for the world the principle of equal and impartial trade with all parts of the Chinese Empire."

The concluding lines are most significant. The United States has openly announced its adherence to the course uniformly urged by the broadest and best informed students of the question—the course advocated in these pages by Minister Denby and Prof. E. P. Allen, by Mr. J. S. Fearon and Hon. John Barrett, by Gen. Wm. Barclay Parsons and Mr. John Foord. With England's vast power directed to the same end, and with Germany and Japan, as may be supposed, acting in unison, opposition need hardly be expected, and, if offered, is foredoomed to failure.

* * *

The awful fire at the piers of the North German Lloyd Line, at Hoboken, has brought out very general criticism and suggestion on certain points of construction and docking practice, but as yet little on the use of wood in ship-building, so far as the spread of fire is concerned. In view of the interest in the Belleisle experiments, it is to be supposed that later a thorough study of the wrecked hulls will be made, and its results are not likely to encourage those who are optimistic regarding the possibility of controlling a fire once well started on shipboard, when wood is present in any large quantity in the form of partitions, sheathing, trim, or furniture. The ships destroyed were all modern craft, built of steel quite as far as is customary in the merchant marine; but the fire seems to have seized them with such frightful rapidity that there was no chance whatever for anyone who was below to reach the decks. And when the fire had once gained headway, the most powerful streams which could be thrown seemed almost without effect.

With great unanimity, however, the press has criticised the danger of tying up these huge vessels, probably close to non-fireproof piers or warehouses filled with most inflammable goods, and leaving them without motive power of their own, or any pre-arranged and sufficient assistance in the way of tugs to move them to safety. They are practically at the mercy of any careless smoker or carrier of fire on the piers, or of any burning barge or lighter which may drift against them.

The second matter which calls out general condemnation is the smallness of the ports. Many of the wretched victims were overcome while standing at open portholes, through which they could call and stretch their arms, but by no possibility could escape. Admiral Melville, U. S. N., who was present at the fire seeking to give help, says: "The most cruel part of it all seemed to be that, had the portholes been a few inches wider, every person would have escaped. It is a common practice in the engineering profession to make what are known as manholes and manhole plates, eleven by thirteen inches, in the shape of ovals, through which an ordinary man of 200 pounds can readily pass. The ports of this fatal ship, which are only eight to ten inches in diameter, are an abomination." Another commentator suggests that if the expense of making all portholes large be considered prohibitory, at least one of sufficient size to permit escape should be provided in each compartment. Neither of these is a lay opinion. It will be interesting to hear from the marine architects and constructors.

* * *

The month which was marked by such disaster to the North German Lloyd has witnessed the maiden voyage of the newest and greatest ship of the other great German steamship company. The Deutschland, of the Hamburg-American Line, finished her maiden voyage to New York on July 12, making the run of 3,044 nautical miles from Plymouth in 5 days, 16 hours, 15 minutes, an average speed of 22.42 knots. This may be compared with the maiden voyage of the Kaiser Wilhelm der Grosse, 3,050 nautical miles in 5 days, 22 hours, 35 minutes, an average speed of 21.39 knots. The Deutschland, second in size of the Atlantic express steamers, with 5,000 tons less displacement and 5,000 more horse-power than the Oceanic, promises to lead the merchant fleets in speed.

REVIEW OF THE BRITISH PRESS

Practical Notes on Electric Traction.

In a paper recently presented before the Society of Engineers, Mr. Algernon Hamo Binyon discussed a number of very practical points connected with electric traction. Although most of these were based upon American practice, they represent the lines along which the probable development of traction in Great Britain may be expected, and hence an abstract of the paper will be appropriate here.

In order to illustrate the extent of the tide of human traffic, a comparison is made between the cities of London and New York. In London the underground railways take only 19 per cent. of the total traffic, while 81 per cent. is conveyed by the omnibuses and tramways. The whole population of London, about 5½ millions, travels 124 times over in the course of a year, while in New York, the population of 3½ millions travels 210 times over in a year; 70 per cent. of the New York traffic being over electric tramways and 30 per cent. on the elevated railways.

It is evident from the above that the underground railways are not taking a sufficient share of the traffic, but this is doubtless due to the discomforts caused by smoke and gas. When the underground roads are operated electrically the traffic will doubtless be greatly increased.

Mr. Binyon says that England cannot expect to destroy the lead which America has secured in the production of electric traction material, but he hopes that British manufacturers will take the matter up seriously and secure at least a fair share of this important work. At the present time the United Kingdom has only about 1,000 miles of electric tramway, while America has 14,000 miles, the number of passengers carried yearly being 3,000 millions in America and 480 millions in Great Britain.

A strong argument is made in the paper in favour of the overhead trolley system, as being the most efficient, least expensive in first cost and up keep and altogether safe and reliable. Much of the unsightliness can be avoided by the use of the side trolley, which dispenses with long brackets.

When the London United and the London County Council Tramways are finished there will be a complete net of quick travelling lines from the suburbs to London. The competition of these electric tramways will doubtless be strongly felt in the future by the railway companies, who will in time be forced to adopt electric traction to cope with suburban traffic within a radius of from 10 to 25 miles round London, this being probably the range within which competition will exist, and beyond which the steam locomotive will beat its rival.

In discussing the question of distribution, Mr. Binyon shows the advantages due to the use of sub-stations, offsetting these with the objections showing that no general rules can be laid down in this matter, as each particular case has to be worked out on its own merits. In some instances the subject of a combined traction and lighting plant has been advocated, but the investigation of this question by Mr. Parshall, Lord Kelvin and Dr. John Hopkinson has shown that this is not generally advisable. The maximum loads in lighting and traction often occur at the same time, so that the total capacity of the station would have to be designed for this combined possible maximum. It is a well demonstrated fact that electricity can be generated at a much lower cost for traction than for electric lighting, so that it seems inadvisable to burden a traction station with lighting service unless the whole plant is a small one.

Concerning the much discussed subject of motive power, Mr. Binyon adheres to the plan of large, slow-moving engines with heavy fly-wheels.

"An engine to operate in electric railway practice must mechanically be of most substantial nature, as there are far greater fluctuations in load in this work than in any other kind, which necessitate special designs fully to meet all requirements. It must not only regulate under these severe conditions, but be proportioned in its entire construction to stand heavy overloads."

"With a heavy fly-wheel and sensitive governor, an engine can cope economically with this special work, if designed to operate economically at about the average load, the fly-wheel having such a weight that its live energy is able to give out the extra amount of work called for by sudden maximum demands.

In view of the scarcity of data about modern electric traction plants, it is not easy to compute the cost of power, but from the estimates of Mr. Philip Dawson and of Dr. Emery for an engine of 500 horse power, the cost of a horse power year, working 24 hours daily, ranges from £8 to £10, while with a plant of 20,000 horse power this may be reduced to about £6.

Mr. Binyon goes into detailed descriptions of trucks, motors, circuit-breakers and rail bonds, and gives data as to the power consumption of cars, showing the relation of the speed and the number of stops to the power required. He advocates the use of meters on the cars, experience in America having shown that 30 to 40 per cent. of power could be saved by the reduction of waste caused by careless handling of the controller.

The whole paper is an excellent presentation of modern practice in electric tramway construction, and as such will be found useful for reference.

American Corliss Engine Practice.

In view of the general interest taken in American power plant design, the articles of Mr. Charles Day upon American Corliss Engines, recently appearing in *The Engineer,* are worthy of comment.

When, with the advent of electric lighting, the single-valve, high-speed automatic engine came into very general use, many people thought that the older, long-stroke engine of moderate rotative speed would soon become a thing of the past. The higher economy of the Corliss engine, however, enabled it to hold its own ground, even though it was at first necessary to drive the dynamos by means of belts. Since the introduction of slower speed electric generators it has become entirely possible to use the Corliss engine connected directly to the dynamo, and for large stations this has become the accepted combination.

The type most generally adopted is the cross-compound, with cranks at right angles, the dynamo and fly-wheel being fixed close together between the cranks. Horizontal engines have been extensively used, but vertical engines are coming into general favour, especially for the larger sizes. An important point in favour of the cross-compound type is that the crank shaft has only two bearings, both of which work under similar conditions of load, hence there is little possibility of the shaft friction increasing materially in consequence of the bearings wearing out of line. By careful proportioning of cylinder diameters the steam economy of compound engines under power house conditions can be made practically equal to that of triple-expansion engines.

Much has been said about the large shaft diameters used in the engines recently designed for electric power stations, but Mr. Day considers these fully justified.

"Taking the consideration of the heavier crank shafts first, as attention has been prominently drawn to this in connection with the tenders for engines for the Glasgow Corporation, experience has taught English engineers what sizes of crank shafts are necessary for the ordinary conditions met with in driving textile and other mills, and what engines I have seen of American design for similar work certainly are not heavier, either in the crank shafts or other parts, than those made by good English firms. This being the case, it is evident that some special necessity must have been found for making crank shafts which have dynamos mounted directly on them much heavier, and with much larger bearings than are adopted for mill engines. Remembering that, in addition to the fly-wheel, the heavy armature of a dynamo is fixed on the crank shaft, it is evident that a stronger shaft and larger bearings are necessary than if only a fly-wheel were required to be carried, but in looking into the list of sizes given further on it will be seen that both the bearing and shaft sizes are greater than are necessary for the mere carrying of the additional weight.

"American designers say that the greatly-increased strength is necessary in consequence of the possibility of the downward forces due to gravity being greatly increased by unbalanced magnetic pull on the armature, as, if by wear, imperfect setting, or any other cause, the center of the armature is below the center of the magnet poles, the magnetic attraction acting downwards may be greatly in excess of that acting upwards. The strength of the shaft and the area of the bearings must, therefore, be such that this additional weight, as it may for simplicity be termed, can safely be carried.

"The amount of this magnetic pull may be very considerable, and a prominent electrical firm give it as 18 tons for a deviation in centers of 1-16 in. of a 600-kilowatt generator. Remembering that the dynamo frame is often carried independently of the engine frames, 1-16 in. deviation is certainly the very lowest that should be reckoned on, and twice this amount would not be unlikely to occur in practice. At one station this unbalanced magnetic pull between the armature and the dynamo frame on one occasion became so great that, combined with the torsion forces, it caused the breakage of all the bolts holding down the dynamo frame. The damage which was done when the pole pieces came into contact with the armature hardly needs description.

"From the foregoing I think it is clear that American engineers have valid reasons for their practice in regard to crank shafts, and until British engine builders have had sufficiently long experience of engines of the class under consideration, the safe policy is to follow the example set by our American *confrères,* so long as the dynamos to be fixed on the shafts are so designed as to render possible the serious unbalanced pull which I have described."

Mr. Day's paper contains drawings and descriptions of a number of details, showing those features which are peculiar to American practice. The willingness of American engineers to show visitors over their works is commented on most favourably, and the rapid strides which American competitors have made, is quoted as sufficient justification of the soundness of this open-minded policy.

The Belleisle Experiment.

THE plan of the British Admiralty to conduct a practical experiment as to the effect of gun-fire upon armour by devoting the Belleisle to destruction by the guns of the Majestic, has attracted much interested attention among engineers. Although it was at first announced that the whole matter was to be conducted with entire secrecy, this condition appears to have been carried out only as regards the first part of the programme, since the Belleisle, after the experiments, was towed to Portsmouth dockyard, where photographs were allowed to be taken, and a general examination permitted.

From a very fully illustrated account in *The Engineer* an abstract of the general results is here given, and possibly some useful deductions made:

The Belleisle was of about 5,000 tons displacement, and the iron armour disposed as follows:

Belt	12 in.—6 in.
Battery	10 in.—8 in.
Redoubt below battery	9 in.—8 in.
Conning tower	12 in.

In construction she may be considered a cross between a central battery ship and a coast defender, originally for Turkey, and purchased by Great Britain in 1878. The Majestic, by which she was attacked, carried 12 in., 6 in., and 3 in. guns, all of which were fired, the 12 in. guns using both common shell and armour piercing shot, while the 6 in. guns fired common shot and lyddite. The attacking vessel proceeded at a speed of 6 knots, the range being 1,300 to 1,700 yards, the duration of fire lasting about 9 minutes.

About 30 to 40 per cent. of the projectiles fired were effective, and a number of the hits were very destructive in their effects. The general result, as might have been expected, was the prompt sinking of the helpless target, but as she had been intentionally moored over a convenient shoal, there was little difficulty in raising her and studying the manner in which she had been affected by the ordeal.

As summed up by *The Engineer*, the immediate conclusions drawn from the experiment were as follows:

Save in absolutely still water, a complete water-line belt has no value whatever.

It is easier to hit a ship end-on than when she presents her broadside.

The battle of the future will be won by whoever gets in the first hit, or first one minute's hitting.

The theorists have been shown to be correct in nearly all their theories.

Danger of fire from woodwork is quite a minor affair, and if the main hoses are protected and the ship well doused beforehand, no serious danger is to be apprehended from fire.

The 12 in. gun is the gun of the future.

To these observations may be added some later ones as to the destructive effects of lyddite. The powerful upward effect of the explosions seems to have been especially marked, the burst-up condition of the decks of the Belleisle showing conclusively the behaviour of the lyddite shells.

The extent to which definite conclusions of value can be drawn from a single experiment of this kind appears, however, to be very limited. It is not easy to reproduce the conditions of actual warfare in any experimental attack. The return fire of the attacked ship would surely do something to affect the accuracy of the attacking fire, and ranges of 1,700 yards would not be reached until after heavier firing at longer distances had occurred. In many cases also the speed of the vessels would be greater than in this experiment. The battle at Santiago was fought at full speed under forced draught, and only toward the close did the range become short, while the Belleisle remained stationary and silent, differing from a land target only in construction, and in the opportunity for ascertaining the probable effects of fire upon the particular class of structure to which the doomed vessel belonged.

To draw any very positive conclusions from such a single experiment seems very doubtful, and it is a question whether the information attained has been worth its cost. The moral effect of the display may have accomplished all that was intended, especially upon nations possessing in their navies a number of vessels not greatly differing in type from the Belleisle.

To the engineer, however, such an experiment hardly appeals as a source of information, and it is not very probable that the builders of guns or the makers of armour plate will make any extensive changes in their methods as a result of the 9 minutes' work of the Majestic upon the Belleisle.

Examinations for Patents.

There is probably no one subject connected with engineering law about which so many differences of opinion exist as that of patents. In some countries the patent is granted to the first applicant; in others the applicant must make claim to be the original inventor. Again, in some instances, the application is granted without regard to the fact of possible anticipation; while in others, the whole state of the art to which the application relates is made the subject of an exhaustive search, and the application is rejected if any previous patent appears to cover the subject, or even if it appears to have been included in any previously published account, although not the subject of a patent.

In view of the fact that a Departmental Committee of the Board of Trade has under consideration the question of possible modifications of Patent Office practice in Great Britain, the subject of the advisability of introducing the examination system into the British Patent Office is discussed in recent issues of *Engineering*, from which we make some abstracts.

The questions under consideration by the committee refer respectively to the subjects of examination as to novelty, compulsory licenses and the granting of patents to foreign inventions. Of these the first is considered at length, and some interesting points, especially in comparison with American practice, are brought out.

As the question is literally put, it relates to the conduct of the office, "in respect of inventions which are obviously old, or which the information recorded in the office shows to have been previously protected by letters patent in this country" (England).

Naturally the determination of the novelty or otherwise of an invention involves the introduction of a system of examination similar to that in operation in the United States, and it remains to be seen how desirable this practice really is. Theoretically, it appears to be all right; practically, it does not always work well. There are two parties to be considered in the case, as is indeed usually the case; one being the inventor, the other the public. If the applicant for a patent is to be saved the expense of a search, and protected, so to speak, from the loss inventors now frequently incur through spending time and money over an invention which turns out to have been anticipated, the public also has a right to be equally informed, and, in case of necessity for defence, be put in possession of the facts already communicated at the public expense to the patentee.

Both in the United States and in Germany, examinations as to novelty are conducted, and provision is made for repeated appeals in case the applicant is dissatisfied with the apparent anticipations made by the examiners.

"The American and German systems are both open to serious objection. The decision in every case naturally depends upon the temperament and the peculiar ideas of the examiner. One examiner, or board of examiners, will recognise the existence of novelty and patentable invention where another examiner, or board of examiners, will be clearly of opinion that there is nothing of the kind. And the fate of an application is mostly determined upon mere documents, and, necessarily, in the absence of such evidence respecting matters of fact, as is usually produced to a Court of Law in the United Kingdom, when it is called upon to pronounce as to the validity or invalidity of letters patent."

It is well recognised in the United States that the most complete examination which the Patent Office is able to make gives no assurance to the patentee that there are no anticipating inventions in existence. The examinations are regarded as a convenient guide to the applicant in framing and amending his specification, but if the invention turns out to be one of much commercial value, it is almost certain to be made the object of infringement, and an appeal to the courts becomes necessary. So generally understood is this fact that it has been said that no American patent is of any real force until its validity has been tested in the courts, the labourious and painstaking searches of the Patent Office being considered of little or no real value.

As a matter of fact, there appears to be no real reason why the recording of the title to an invention should be greatly different from that of any other piece of property. No attempt is made to inquire into the validity of the title to a piece of real estate at the office where it is recorded, that being left altogether to the interested parties, and if questioned is decided by the courts. Years of experience in America have shown that the examination system does not in any way replace appeal to the courts, and the small esteem in which it is held in the United States should be fully appreciated in Great Britain before the proposed change is made.

Electric Traction on the London Metropolitan.

Everyone who has traveled upon the Metropolitan District Railway has doubtless rejoiced to hear that a beginning has at last been made towards the replacement of steam traction with electric driving. The preliminary experiments have been made upon a short piece of line only 4,000 feet in length, between Earl's Court and High street, Kensington, and from an account in *The Electrical Engineer* we abstract some details of this installation.

Two lines of conductors are used, one on each side of the track, for the lead and return currents, the conductors being of inverted steel channels of section corresponding to one square inch in conductivity. The current passes from the conductors to the motors by means of sleepers, and as there are a number of gaps necessary in the conductors, a slipper is placed on each carriage, so that one end of the train makes a contact before the other runs off. The number of contacts also prevents undue sparking.

The train is provided with a motor coach at each end, each coach having four motors, of the Siemens railway type. The controller is so arranged that the motors all start first in series and end up by all being in parallel at maximum speed, and as each motor has a maximum capacity of 200 horse power, each coach has a total of 800 horse power.

The power plant is equipped with Babcock and Wilcox boilers and Belliss engines, there being two generating sets, with two-pole dynamos, compounded to give 500 volts at no load and 550 volts at the full load of 385 amperes. Curves showing the results of tests are given. "On a two-hour continuous run without undue heating, the motor, with a current of 250 amperes, gave a pull of 2,300 pounds, at a speed equal to 25 miles an hour. A further test on the line itself showed that the electric locomotive was much more powerful than the ordinary steam locomotive on the line. This was shown by the fact that a steam locomotive was unable to pull up the grades the electric train loaded to 220 tons. After this had been proved, steam was shut off, and the electric locomotive started the train with the steam locomotive coupled to it and took the whole up the grade easily. As regards the acceleration obtained this proves to be nearly 1.25 feet per second. Owing to the small amount of generating plant, however, this acceleration cannot be maintained after the motors are in parallel, as the current available is too little.

"Maximum speeds of 38 to 39 miles per hour have been reached, and great improvements on the scheduled times with steam locomotives are obtained. Quicker travelling and more accommodation is thus ensured by the electric train, in spite of the fact that the experimental equipment is loaded by the weight of an idle locomotive. These inducements are great, and should be quite sufficient to ensure the complete conversion of the Inner Circle."

While the above advantages are undoubtedly worthy of consideration, they are altogether subordinate to the one great object of the avoidance of smoke and gases. There is little doubt that the Metropolitan would be far more extensively patronised were it not made so offensive by the suffocating atmosphere, and with these objections removed, a large increase in the number of passengers would follow.

An underground road appears to be especially well adapted for electric traction, the complete control which is possible over the entire way rendering it possible to use devices and methods which would be out of the question upon the streets of a city. It is to be hoped that this experimental section of electrical traction will prove to be a forerunner of the early and complete abolition of steam traction upon the whole of the Metropolitan system.

The 1000-Mile Automobile Trial.

THERE is abundant evidence on every hand that the automobile is emerging from its original position as a pleasure vehicle into the much more important one of a commercial and business proposition. Much of the progress in this direction has originated in England, where the pleasure vehicle has until now made far less progress than in France. The heavy motor trials at Liverpool added much to our knowledge as regards that class of traffic, and the trial of 1,000 miles run, recently completed under the auspices of the Automobile Club, has been a useful contribution to the solution of the problem of endurance.

A general review of the trial, as given in *The Engineer,* enables some conclusions to be drawn from the trials which may be of advantage in designing future vehicles, and an abstract will be of interest. The tyres were naturally the principal feature which the trial really concerned. All the tyres were of rubber, and most of them were pneumatic. In most cases repairs of tyres were necessary, and almost every vehicle experienced trouble in this respect. The solid rubber tyres fared better than the pneumatic, but some satisfactory substitute for either form appears to be most desirable.

It is unfortunate that but two steam carriages were represented at the trials, since neither of them came out well, and hence steam as a motive power was not seen to advantage, while had a greater proportion of steam-driven vehicles competed, the result might have been different. Apart from trouble with the tyres the principal difficulty appeared to be the action of the wind on the oil lamps under the boilers, while priming was also a difficulty. Clearly the boiler is the vital part of a steam automobile.

So far as the definite result of the trials is concerned, there appears to be no doubt as to the success of the internal combustion motors. Certain defects, such as the blowing out of the flames of the ignition tubes, and the noisy action of the gearing, made themselves apparent, but with these exceptions the vehicles of this class undoubtedly showed their superiority.

Among the immediate lessons to be learned by the trials, several points of practical value may be mentioned. For use on common roads, with all the irregularities which must necessarily be encountered, lightness must be sacrificed, and strength given the most consideration. As the weakest link in a chain is the measure of its strength, so the roughest place in a road is the measure of its condition. Bearing this in mind, it is evident that by strengthening the framing, making the wheels a little heavier, fitting more durable tyres, and, above all, providing a fair margin of excess power, many vehicles which were right in principle would have shown better results in practice. The desire for lightness is responsible for the development of many apparent defects which would not have appeared had but little more care been given to strength and power.

Taken for all in all, the trial was very satisfactory. The general result, regardless of the performance of individuals, showed that the motor vehicle is a thoroughly feasible machine for long-distance road traffic, even over roads of a difficult character. Electricity as a motive power has been relegated to its proper place, as suitable for short distance work, especially in cities, but for general road traffic the competition lies between the steam engine and the internal combustion motor. For heavy trucks it appears that steam power, properly applied, has many advantages, while for lighter vehicles the internal combustion motor is both convenient and satisfactory.

Such trials as that recently held must go far to popularise the motor vehicle and to dispel much of the prejudice existing against it in certain quarters. The noise, even of the noisiest petroleum motor, is not so great as that made by a pair of tramping 'bus horses, nor is the odour of escaping vapour as objectionable as that caused by the filth due to the horse. A few more such public exhibitions of the real nature and advantage of mechanically propelled vehicles will do more to bring about the coming displacement of the horse by the machine than all the articles which can be published anywhere.

The Development of Electricity.

The recent address of Mr. A. W. Heaviside before the Newcastle Section of the Institution of Electrical Engineers, delivered at the Durham College of Physical Science, and published in *The Electrical Engineer,* constitutes a very complete review of the development of the modern practical applications of electricity.

Starting with the introduction of telegraphy in 1837 by the almost simultaneous inventions of Wheatstone and Cooke, Steinheil, Bell, and Morse, through the Hughes printing apparatus and the Wheatstone automatic system, the review, down to the cable and the telephone, Mr. Heaviside manages to cover this portion of the field very fully, yet in a most condensed form. In following the development of electrical methods of communication it can now be seen how naturally the successive inventions grew out of each other, and, with a few unfortunate exceptions, how each discovery falls into its proper place in what almost appears as a predetermined scheme.

Many of the practical details of space telegraphy are now seen to have been existent in connection with improvements in telephony, and the latest achievements which have been made in telegraphy across space are seen to be the results of the combined work of many minds, all contributing to the success which Marconi has attained, and which is by no means yet completed.

Historically and practically electric lighting naturally follows communication, and here Mr. Heaviside gives space to the work of Mr. Swan, who did for incandescent lighting in Great Britain what Edison did in America.

Coming to electric generation as a necessity in all subsequent work, the Parsons steam turbine is referred to as a prime mover, partly because of its relation to Newcastle industry, but largely because of its successful application to the driving of electrical generators.

So far as power stations go, we may well leave Mr. Heaviside to state the question in his own words; it cannot be better done:

"Suppose we build anew on the experience gained. Cease to put down what now may be considered toy machines all in a row, and tobacco-pipe chimneys, jealously watched by vigilant smoke inspectors catching the specks upon sheets of white blotting paper. Emulate the courage of the Americans, the Swiss, and the Continent generally. Don't adopt expediency, either as to site or anything else; then that peace of mind which belongs to solid far-seeing work overtakes the engineer and his friend the capitalist. They may smoke the pipe of peace with the imperturbability of a Turk, and wait. It must come. Every house will eventually have its electric light, as it will have its telephone. Purity, steadiness, and convenience save its extra nominal cost over other illuminants now, and continuous production will reduce gas companies' dividends from lighting alone to something exceeding small by-and-by. Hence the future of the electrical engineer augurs happily—he, the maker of this good thing, who only the other day, and, alas! even now, is so lowly rewarded for his labours as not to be lauded by his neighbours.

"On the distribution side of the question there is a danger. A large central power-house, if there is to be economy, means high-pressure, alternate-current transmission of, say, 50 periods uniphase, if it will do (by no means improbable in the near future), and more phases if it will not, to as near the point of consumption as possible. Large low-tension services are to be deprecated, especially where coal is cheap. The fewer the transformations the better, and preferably of the static than of the dynamic order. In other words, do not have moving parts demanding human watchfulness, except where it is imperative, as for straight currents for electro-chemical work. Alternating currents needing no brushes will do all the rest. This may be rank wickedness to some trade interests, but it is the goal. Simplicity is what is wanted, not complication. There must be a point where the cost of long-distance transmission overtakes the economy of centralised production. That point has to be determined; our grandmother, the Board of Trade, will have something to say about that. We are not as free as the winds, as in Switzerland, where a dab of red paint on an insulator on a pole supporting multitudinous services marks sudden death if disregarded, locating as it does the extra high-pressure service, and where magistrates rightly treat the idle breaking of an insulator as a crime, thus acting for the public interest as the British Post Office does when a penny letter is stolen.

"Motive power by electrical agency is as convenient as going to the poulterer for your ducks, instead of keeping your own duckpond. It is this principle that makes for success with power work. Nothing can stop it. What so cleanly, so simple, as getting all that is needed by turning on a tap? No space is occupied by a steam plant, no capital locked up in its purchase, and no standing charges in its maintenance. There is no waste during holidays or strikes, and one care the less is borne by the user. This is the age of specialists, another name for the division of labour—without them the work of the world would not go on. Scatteration of effort is dissipation of energy. The user with the specialist at his elbow is relieved mentally, thus brain power is released for concentration on his own specialty."

REVIEW OF THE CONTINENTAL PRESS

Micro-Metallurgy of Steel.

THE microscopical study of the internal structure of metals is becoming of great practical importance, for it enables us to solve many of the problems which the ordinary testing methods leave unanswered, and helps to a clearer understanding of the underlying causes to which all the observed phenomena are due.

Recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* contain a communication from the Royal Testing Laboratory, at Charlottenburg, in which Herr E. Heyn describes some of his very thorough and interesting work in metallography. He says that researches in this field show clearly that metals and alloys in the solid state have an internal structure resembling that of rocks. We have long been accustomed to ascribe all mechanical changes in metals directly to molecular displacements, but metallography has thrown a new light on this subject. It shows convincingly that only in the rarest cases are metals and alloys homogeneously built up of molecules, but are rather a conglomeration of microscopic particles, which latter may be well defined groups of systematically arranged molecules. These groups of molecules are the structural elements with which metallography deals, and are conveniently designated as granules. Neighbouring groups in a metal or alloy may contain molecules of the same kind, whose arrangement from granule to granule may, however, be different. The various groups will then differ physically, but not chemically. It can also happen that adjacent granules are composed of different kinds of molecules, and they will then differ chemically as well as physically. It is the province of metallography in the first place to ascertain the number, the kind, and the properties of the individual groups, and then to determine the influence of these factors on the properties of the metal or alloy as a whole. Herr Heyn conducted the experiments described in his article with a view to getting an answer to the question: What changes are undergone by the individual structural elements of certain metals, when these latter have their shape changed when cold and are then subjected to high temperatures?

He confined his investigations to copper and low-carbon ingot steel.

The minute structure of copper and iron in the pure state bears a certain resemblance to the structure of marble. The latter consists of small calc-spar granules, whose surface is generally irregular, but which exhibit all the essential attributes of crystals. Pure copper consists of small granules of copper, pure iron is composed of small iron grains, which, in the language of metallography, are called ferrite granules. These granules are generally of microscopic dimensions, but are occasionally visible to the naked eye. Like the calc-spar grains in marble, they possess all the properties of crystals, even though they may lack the outward marks of plane surfaces disposed at constant angles with one another. Their bounding surfaces are more or less irregular, owing to the mutual inter-growth of neighbouring granules.

The most convenient way of showing that these granules do possess a true crystalline structure is by producing so-called etched figures on their surfaces. It has been found that when crystals are treated with an etching fluid, minute figures, geometrically regular, are formed on their surfaces. These figures are the same for similar surfaces of the same crystal, but differ for dissimilar ones. They are produced on sectional surfaces as well as at the outer natural ones, and they are infallible indications of crystalline structure, for they never occur on amorphous bodies. Now, if a polished metallic surface is treated with some appropriate fluid a is found that these etched figures are duced on the granules, it follows tha structure of the granules is crystalline. This is, in fact, the case, and the microscopic study of etched surfaces forms a very important branch of metallography.

Herr Heyn treats of his experiments on copper and steel at considerable length, and we shall have to confine ourselves to a few of the results he obtained in his experiments with steel.

As has been already mentioned, iron in its pure state consists of crystalline ferrite granules. When carbon is added, there is an instant change in the internal structure of the metal. About the boundaries of the ferrite granules a new substance is visible, whose quantity grows with the increase of carbon. It is found that this substance, which has received the name of pearlite, is an intimate mixture of thin lamellæ of ferrite and yet thinner lamellæ of a chemical combination of iron and carbon, Fe_3C, which bears the name of cementite. Low-carbon irons and steels are composed of a conglomeration of ferrite and pearlite, but when the carbon reaches about 0.8 per cent. the ferrite granules disappear, and only the pearlite remains.

In the low-carbon steels and in other metals and alloys where the crystalline granules form the larger part of the internal structure, it is of importance to determine the average size of these granules. Herr Heyn does this by etching a steel surface with copper-ammonium chloride, or with nitric acid. He fixes the boundaries of a large enough field of view, using a microscope of comparatively low magnifying power (100 to 350), and then, with a high magnifying power which brings out the etched figures clearly, the number of ferrite grains within the chosen boundaries is counted. The total area is found by means of a planimeter, that occupied by the pearlite substracted, and the remainder divided by the number of ferrite granules, which gives the average area of the latter. This surface unit serves at the same time for a measure of the average volume of the granules.

It is necessary in counting the granules to have a magnifying power high enough to bring out the etched figures, for otherwise it is difficult to distinguish the boundaries between adjacent granules. As these granules are arranged irregularly, they present dissimilar faces at the etched sections, and so the character of the figures varies from granule to granule and makes it easy to distinguish between them.

One series of experiments was made with a very-low-carbon steel wire, which consequently was built up largely of ferrite granules, with only a small proportion of pearlite. At all stages of the investigation, cross-sections of the wire showed a sharp demarkation between an outer light-coloured zone and a dark inner one, which were differentiated as far back as the original cast ingot. The sizes of the granules in these zones differed materially, the grains in the outer zone having from one-and-a-half to four times the area of those in the inner.

The material was in the form of a rolled rod of 5.2 millimeters diameter, and a 3.7-millimeter wire drawn from it. Sections of the original rod showed that the ferrite granules, speaking roughly, had the shape of cubes, or, at least, that their surfaces parallel to the axis of the rod were equivalent to those at right angles to the axis. But when the rod had been pulled apart in a testing machine, it was found that the granules near the break had been stretched out so that, although their volume remained about the same as before, their diameter in the direction of the pull was about twice as great, while their area at right angles to the rod's axis was correspondingly smaller.

When the 3.7-millimeter wire was examined after being cold drawn, the granules showed a considerably reduced volume. Their length in the direction of the wire's axis remained about the same as in the original rod, but their cross section was only about one-fifth as great as before. It follows, that, in the process of drawing, the original granules were broken up, and, consequently, that the number of granules per unit volume was greater after drawing than before.

When the drawn wire was subjected to a temperature of 417° C. for half an hour, there was hardly any appreciable effect upon the granules. When heated for the same length of time to 616°, however, there was a decided change in the length of the granules, it being reduced to about one-half, while their cross-section remained the same. There must, therefore, have been a breaking up of the granules which had been previously subjected to the cold-drawing process. But there still remained a distinct stratification parallel to the axis of the wire.

When, however, the wire was heated for half an hour at a temperature of from 950° to 970°, there was a complete transformation in the internal structure. Every trace of the stretching or stratification vanished. The size of the ferrite granules had become entirely independent of that of the original grains in the drawn wire. This was shown by the fact that the granules in the new condition were larger, the slower the rate of cooling down from 950°. This indicates that there was a complete re-crystallisation of the material. After this, when the wire was again heated to about 600°, not the slightest change in the structure could be observed, which is remarkable because the original drawn wire underwent a structural change at this point.

The changes caused by heat in the form and size of the ferrite granules depend, therefore, upon the condition of the metal when heating begins. If the metal is in a strained condition, due to having had its shape altered when cold, a change will take place in the size of the granules at a comparatively low temperature. If, however, the metal is in its natural state, a thorough-going change will occur only above a fixed temperature (the crystallisation temperature), and any subsequent heating below this temperature will have no influence on the size of the granules.

Movable Conveyors for Blast-Furnace Charges.

Among the mechanical appliances for facilitating blast-furnace work in the United States is the inclined elevator, which conveys ore, flux, and fuel to the mouth of the furnace with a very small expenditure of labour. But this elevator is fixed, so that it can serve only one furnace, and in an extensive plant there must be as many elevators as furnaces. Besides, if an elevator gets out of order, its furnace is put out of blast.

In order to overcome these difficulties, Herr Fritz W. Lürmann proposes various plans in a recent number of *Stahl und Eisen*. In his first plan, the storage bins for ore, limestone, and coke are so arranged that the buckets can be run underneath and filled through sliding doors in the bottom of the bins. The buckets are then run on trucks to a travelling crane, which hoists them vertically and carries them horizontally to a second crane. This latter crane travels on a structure running over a row of furnaces in such a way as to command them all. Reserve cranes are provided for, in case of accident, so that there need be no interruption in the work of charging the furnaces. This method, however, is not strictly continuous, as it involves at least two changes, one from the truck to the first crane, and another from the first crane to the second. In the next plan, a single travelling and revolving crane is substituted for the two travelling cranes. This revolving crane takes the buckets from the trucks and conveys them right to the mouth of the furnace, and as it travels on rails parallel to a line of furnaces, it can take care of several.

The third plan goes a step further and provides for chutes in the sides of the storage bins, so that the buckets can be directly conveyed by a travelling and revolving crane from the place where they are filled to the mouth of the furnace.

A fourth project calls for a conveyor of the Brown type, but which can travel so as to command several furnaces and also reach all the storage bins.

The fifth plan is somewhat similar to the preceding, but involves the use of Hunt conveying and hoisting machinery with a long inclined cantilever travelling crane.

In all these plans the motive power can be gas, steam or electricity.

In this connection it is interesting to notice how much attention is now being paid by the Germans to labour-saving devices of all kinds, and particularly to hoisting and conveying machinery for materials. American apparatus and methods are being closely studied in Germany, and as a result are being widely applied.

Experimental Railway Work with High-Tension Rotary Currents.

In the wonderful development of the electric railway during the past decade the direct current has played by far the most important part. In other fields the rotary or polyphase current has of late made marked advance, but heretofore there has been but little direct application of it to railway work. For short-distance railroads, and particularly for city trolley lines, the direct current possesses marked advantages. Where there are violent fluctuations in the load, as is the case with a trolley car making frequent stops and climbing sudden grades, the direct-current apparatus can be used to better advantage, and for the same service is lighter and cheaper than rotary-current motors would be. Moreover, the complicated nature of rotary-current wiring, both in the overhead network and in the connections aboard the car, prevents the direct use of these currents in city railway work. They will probably be employed to best advantage on trolley roads in an indirect way. High-tension polyphase currents will be generated at some place where power can be conveniently obtained, and will be transformed down by rotary transformers, at the points where they are to be used, into direct currents of comparatively low voltage. Some plants already employ this method, which has several points of superiority.

But it is in long-distance railway work that the rotary current has an opportunity to play a leading part. Here cars can make long, continuous runs at uniform speed, where the polyphase motor will appear to best advantage, and high-tension rotary currents can be economically transmitted on bare overhead conductors and taken off by sliding contacts attached to the moving cars. If the voltage be not too high, the currents can be directly supplied to the motors, but with very high pressures the currents will be transformed down by stationary transformers carried on the cars.

Some extensive experiments have recently been made with this system by the Siemens & Halske Company, near Berlin, and they are described in the *Electrotechnische Zeitschrift* by Herr Walter Reichel, the engineer in charge.

A standard-gauge track, 1.8 kilometers long, was laid along an unfrequented country road. There was only one curve, of 200-meters radius, on the main line, while there were two sharper curves on the branch leading to the power house and car sheds. The power house was situated about the middle of the line, and got direct current from an external source to charge a storage battery and run a motor, which, in turn, drove a rotary-current generator. The latter is a twelve-pole machine, the connections of whose winding can be altered so as to furnish pressures from 385 to 4,000 volts. It runs normally at 500 revolutions per minute, and the rotary current has 50 periods per second. There is also a transformer which can increase the electromotive force from 750 to 10,000 volts. This made it possible to conduct the experiments with three different line voltages:

1. 750 volts, which was used by the car motors directly.
2. 2,000 volts, which was also used without transforming.
3. 10,000 volts, which was reduced to 750 volts by transformers on the locomotive.

As the experiments were conducted on a public highway, it was necessary to place guard wires beneath the overhead conductors, so that the ordinary methods of taking off the current by underneath contact, either rolling or sliding, were not applicable. Two methods were tried. In the first the current was taken off by three horizontal arms extending from an upright post on the car and making sliding contact with the upper surface of the working conductors. This arrangement was afterwards abandoned in favour of the following: The three parallel conductors, of hard copper wire, 8 millimeters in diameter, lie in a vertical plane, 1 meter apart. They are supported on strong porcelain insulators, triple petticoated. Attached to the upper part of the line poles are pieces of iron, shaped like a long bow, on a flexible part of which, corresponding to the bow string, are fastened the insulators. The poles themselves are strong, latticed iron columns, firmly embedded in the ground to a depth of 1.9 meters, while those poles which have to withstand the side pull of the wires are surrounded with 1.5 cubic meters of cement. The poles are 40 meters apart on tangents, and closer together on curves, and each is carefully earthed by connecting it to the rails with stout copper wires, so that even if there should be any leakage of the high-tension current, the danger in touching the poles will be minimised.

The guard wires consist of four parallel galvanized-steel wires, 5 millimeters in diameter, connected at intervals of 1.5 meters by cross wires. They are supported by arms projecting from the poles, below the working conductors. Current is taken off the conductors by three stirrup-shaped wires at the ends of movable arms on top of the electric locomotive. These arms extend up sideways from the locomotive and are inclined at different angles so that the stirrup wires can press against, and make good sliding contact with, the working conductors.

The electric locomotive was built up on an ordinary railway-car truck with two axles. The total length of the locomotive, including the buffers, is 6.3 meters, the width of the platform 2.2 meters and its height above the rails 1.2 meters. The body of the locomotive is of sheet iron. The central part is occupied by the motorman, and has glass windows in front and behind, and doors at the sides. On the roof is the structure to which the sliding-contact arms are attached. The fore and after parts of the locomotive are lower than the central portion, and have inclined tops which can be lifted up. They contain the transformers, resistances, high-tension switch, and air compressor. The whole locomotive is of metal, and all the parts are well earthed. The total weight of the locomotive, completely equipped, including the motors, is 16,000 kilograms.

There are two rotary-current motors, one on each axle. The ones used in the third series of experiments, with a line pressure of 10,000 volts, were designed for a voltage of from 650 to 850, and had each a normal output of 30 horse-power, which could be increased to a maximum of 120 horse-power at 650 volts. The electromotive force of the line current is reduced from 10,000 volts to 750 volts by the stationary transformers placed in the ends of the locomotive, and the current is then led to the motors through the controllers, which are designed so as to allow several variations to be made in the speed and in the power.

The experiments were decidedly successful. A speed of 60 kilometers per hour was reached when hauling a load of 30 tons, and it was demonstrated conclusively that it is practicable to take current from the line at pressures up to 10,000 volts and use it, after transforming down, for driving motor cars. The apparatus used proved thoroughly reliable, and can serve as a guide for future practical work.

Aluminothermie.

When aluminium and oxygen enter into chemical combination, there is evolved a higher temperature than can be generated in any other artificial way except by electrical methods. For a long time this fact was not generally recognised, partly because aluminium was more or less of a chemical curiosity and its production was confined to the laboratory; but of recent years, since it has become an important technical product, its properties have been more widely investigated and new facts concerning it discovered.

The work of Dr. Hans Goldschmidt in this field has laid the foundation for an important new industry, to which the name of "Aluminothermie" has been given. This term covers, in general, those processes in which high temperatures are produced by the combination of oxygen and aluminium, and various developments of Dr. Goldschmidt's inventions are described by him in a recent issue of *Glückauf*.

The chemical reactions involved are very simple. Oxygen is not taken from the air, but is used as combined with the metals in the form of metallic oxides. As an example, take iron oxide, of common occurrence in nature as some of the iron ores. If metallic aluminium, finely divided, be mixed with a powdered iron ore and a reaction made to take place, the resulting products will be aluminium oxide and metallic iron, and at the same time a very high temperature will be evolved.

The problem has been to start the reaction. Most of these mixtures of metallic oxides and aluminium will burn only at high temperatures. They could be stirred with a glowing rod without any combustion taking place. The application of external heat would not answer, because the heat which would cause the mixture to burn would damage the crucible containing it.

A solution of the difficulty was reached when it was found that there is a class of oxides, which, when mixed with aluminium, are easily ignited at a low temperature, and after ignition evolve very high temperatures. It is only necessary, then, to sprinkle an easily inflammable mixture, such as barium superoxide and aluminium, on the refractory one, and then light the former, which can be done most easily with a large match. The kindling mixture will burn and generate a high temperature, and so set the main mixture on fire. More of the latter can be added from time to time, as desired, and will react with the evolution of as high temperatures as the combustion of the first portion generated.

There is thus afforded an extremely convenient means of obtaining great heating effects at any place, without the use of machinery or any complicated apparatus. The temperatures resulting from the reactions described can only be estimated, as there are no means of determining them exactly, but they are considerably over 2,000° C.

The practical applications of this process already embrace wide limits. A direct result of the chemical reactions is the separation of the metals from their oxides in a pure state. The combinations take place in a regular way, according to chemical laws, but the mixtures are always made with an excess of oxide, so that all the aluminium will be oxidised and no metallic aluminium left to form alloys with the other metals.

The process is applied with special advantage to metals which it has not before been possible to isolate completely, but which now can be separated in an entirely pure state, free from even carbon. Among such metals, one of the most important in a metallurgical way is chromium. Almost all the chromium which has heretofore been used in steel metallurgy contains a considerable percentage of carbon, and is to be regarded as chromium carbide. All the chrome steels are, therefore, strictly speaking, chromium carbide steels, and have their properties materially influenced by the combined carbon. But it is now possible with the pure chromium to form steel alloys whose properties are decidedly different from the old chrome steels, and which can also be made to contain larger percentages of chromium.

In the same way pure manganese is produced, which finds a wide application in the making of manganese bronzes, free from iron, and, also, in special manganese steels. This pure manganese possesses the desirable property of not disintegrating on exposure to the air, as does the ordinary carboniferous manganese, and it also particularly distinguishes itself by its easy formation of alloys with molten copper, tin, zinc and other metals. Copper alloys containing 20, 30, 50 and even higher percentages of manganese are formed with extreme ease by the pure manganese.

Among other metals of growing importance in metallurgy which are prepared by this process may be mentioned titanium and boron.

A most important bye-product is the melted aluminium oxide, which is formed simultaneously with the separation of the pure metals. This product is really an artificial corundum and has been called "corubin." It is distinguished by its great hardness, and for grinding and polishing purposes far surpasses natural corundum and emery.

But perhaps the most important practical application which is made of this process is in welding. For this purpose there is used a mixture called "thermit," consisting essentially of iron oxide and aluminium, which is kindled by one of the easily burning mixtures previously described, and burns with the evolution of great heat in a specially prepared crucible made of corubin, magnesia, or some other very refractory material. The surfaces of the parts which are to be welded are carefully cleaned and polished, and pressed together by a framework with screws. A mold is placed around the joint and into it is poured the fluid mass from the crucible. The heat and pressure do the rest. In the crucible, before pouring, there are two strata. The lower consists of fluid iron and the upper one of the lighter melted aluminium oxide. When the pouring begins, the alumina which first flows into the mold quickly cools and forms a thin layer on its inner walls as well as on the pieces which are being welded. The rest of the alumina and all the iron remain fluid for a short time in the mold. In consequence of the solid coating of alumina, the molten iron does not touch the surfaces of the mold and the welded piece, and when the whole mass has cooled down, it can be removed by a couple of light hammer blows. The welded piece has not been deformed by the attachment of any fused iron, and the mold is not injured and can be used repeatedly.

By many experiments it has been carefully determined just how much of the heating mixture is necessary for a weld of a given size, and what the capacity of the mold must be. In this way it is possible to know beforehand the amount of heat required for a weld. This is an advantage which no other welding process possesses, as these are all based on empirical methods and require an experienced eye and hand to be carried out successfully. The new process can be applied by ordinary workmen, after a very little practice. Another advantage of the new method is that the heat is concentrated just at the place where it is needed.

This process is particularly applicable to rails of electric railways and to pipes for steam, gas and water, as these can all be welded in any position and at the places where they are in use.

The molten iron can also be used to repair defective or broken parts, by casting it right on to the original piece and working it into proper shape after cooling.

Only a few of the leading applications of this process have been here given, but there are enough to show that it bids fairs to mark a distinct advance in metallurgical fields.

The Poulsen Magneto-Telephonograph.

The telegraphon, or magneto-telephonograph, an invention of the Danish engineer, Valdemar Poulsen, makes use of the fact of permanent magnetism to record tones and sounds in a simple manner, so that they can be reproduced whenever and as often as desired.

The inventor proceeded from a well-known phenomenon: If a magnet be drawn over an iron or steel plate, the intensity of the permanent magnetism will be altered at all the places so touched. This can be readily shown by sprinkling iron filings over the plate, when they will arrange themselves in the path which the magnet has followed.

This phenomenon gave Mr. Poulsen the idea that it must be possible to record magnetically the changes in the core of a telephone on a steel wire moving past the telephone magnet pole. If this wire, which has been thus permanently magnetised in a direction perpendicular to its axis with an intensity varying from point to point, be then moved before the pole of a small electromagnet, it will induce currents in the coil of the latter. These currents, when led to a telephone, will there cause the original sounds given out by the first telephone to be reproduced.

Experiments confirmed the correctness of these views, and, after two years' work, the idea has been embodied in a simple apparatus which meets the requirements of every-day practice.

In one form of the apparatus there is a cylinder about 14 centimeters in diameter and 25 centimeters long, on which a steel or nickel wire, 1 millimeter in diameter, is wound in a spiral groove. Resting on a bar and directly over the spiral wire is a small double electromagnet, whose core consists of a soft-iron wire 1 millimeter in diameter. The poles of this horse-shoe electromagnet are pointed and brought near together on opposite sides of the spiral steel wire, which they almost grasp. While the sounds are being recorded, the cylinder is revolved by clockwork or an electromotor, and at the same time the electromagnet travels along its supporting bar. The coil of the electromagnet is in circuit with the secondary of an induction coil, whose primary is connected with a microphone transmitter and battery. As a preliminary step, the spiral steel wire has been already uniformly magnetised at right angles to its length by this same electromagnet in circuit with a constant battery. If then, the microphone transmitter be spoken into while the cylinder is turning, it can be seen that the varying current in the electromagnet will cause the permanent magnetism of the spiral wire to be strengthened at one point and weakened or even reversed at another.

When the same electromagnet is afterwards connected with a telephone receiver and moved along the spiral wire, the varying permanent magnetism of the latter will induce, in the magnet coils, currents which, led through the receiver, will cause the original sounds to be reproduced.

Experiments have shown that speech can be thus reproduced 1,200 times without weakening the original impression. When it is desired to wipe out a record, the electromagnet, as in the first instance, is attached to a constant battery and run over the wire, thus magnetising it uniformly once more and preparing it to receive a new message.

A cylinder, such as described above, will record a conversation lasting only about a minute. When longer conversations, of from ten to fifteen minutes' duration, are to be recorded, there is employed a modified form of apparatus, in which a steel ribbon, 3 millimeters wide and 0.05 millimeter thick, takes the place of the spiral wire and cylinder. The steel ribbon winds off one axle and on to another, like the paper tape of a printing telegraph, passing close to the recording electromagnet on the way. A third modification is used to distribute news by telephone. A rather short, endless steel ribbon, about 4 centimeters wide, revolves continuously around two axles. It first moves by the recording electromagnet, then past a large number of transmitting electromagnets and finally past a wiping-out electromagnet, which removes all traces of the record and prepares that portion of the ribbon to receive a new impression when it again reaches the recording electromagnet.

Each of the transmitting electromagnets is connected with a receiver belonging to a subscriber to the telephone "newspaper."

Mr. P. O. Pedersen, who has been associated with Mr. Poulsen in the development of the telegraphon, has perfected a very ingenious device by which two conversations can be either simultaneously or successively recorded on the same wire, or ribbon, and afterwards clearly reproduced without interfering with each other. He simply uses two electromagnets instead of one. The two are placed close together and have their coils connected in series. In the first place, a conversation is recorded just as described before, except that there will be a duplicate record, corresponding to the two electromagnets. The connections of one of the electromagnets are then reversed, so that the current flows through it in the opposite direction, and another record is taken. The two electromagnets now produce opposite effects. While one strengthens the permanent magnetism of the steel wire, or ribbon, the other weakens it, and vice versa. This record is made right on top of the first. In order to understand this more clearly, take a point of the wire, *a,* between the poles of the first electromagnet, and another point, *b,* between the poles of the second. In the first case considered, when the polarity of the electromagnets is the same, the permanent magnetism of the wire at *a* and *b* will be strengthened at the same time, or weakened at the same time. But in the second case, where the electromagnets have opposite polarities, the magnetism at *a* is being strengthened while that at *b* is being weakened, and vice versa.

In order to reproduce the first record, the electromagnets are connected just as they were when it was made. They will then be influenced by the first record, while the second will produce no effect, because, owing to the opposite magnetisations at *a* and *b,* opposite currents will be induced in the two electromagnets and will neutralise each other. When the electromagnets are connected in the second way, however, they will be influenced only by the second record, the magnetisation due to the first record now inducing opposing currents in the reversely connected coils.

The same general arrangement is employed for sending two messages simultaneously over the same wire in the same direction. At the sending station a transmitting electromagnet sends the combined records to the receiving station, where they are recorded again. Each record is there selected by an appropriately connected pair of electromagnets.

This general description, taken from the *Electrotechnische Zeitschrift,* shows that the theory of these methods is clear and simple. It appears rather remarkable, though, that the quantitative effects of the permanent magnetism are great enough to produce good results, but the work done so far gives great promise that a real improvement has been made in telephony.

REVIEW OF THE AMERICAN PRESS

Central-Station Economies.

In an interesting and very clearly put paper before the National Electric Light Association, published in full by the *Electrical Review,* Mr. W. L. Abbott deals with "Operating Economies in Central-Station Practice"—with the work, that is, which comes into the field of the manager rather than that of the designer of the electric power house.

He alludes appreciatively at the outset to that freedom in imparting information which has been said to be characteristic of American works, as a chief factor in the rapid improvement in operating details now under way. Local conditions must largely control the methods adopted in any particular station, but free interchange of experience and readiness to make trial of new ideas furnish the material out of which "natural selection" will evolve "the unwritten code of rules" for the special instance.

Perhaps the most important methods set forth by Mr. Abbott are those which he reserves for the latter part of his paper, and which deal with the management and control of the station labor. The problem for the manager is so to arrange the pay roll and operating force "as to get the maximum results with the least expenditure of money." This requires that the force should at all times be adequate for the work required, that wages should be carefully graded according to duties, skill, and responsibility imposed, and that the return to the workman should include an element of incentive and expectancy of promotion, unmarred by favoritism and petty works-politics.

The division of the force into a night gang and a day gang, once quite general, Mr. Abbott finds ill-adapted to central station requirements. The hours are too long, the distribution of labor is not the best, and the system is too inelastic. "The number of men in the station does not vary according to the load. The practice which we instituted several years ago, of bringing the men on one or more at a time, an hour or so apart, and letting them off in the same way, we find can be made to meet exactly the requirements of an uneven load, and enables us to rotate the different men of the same class through all the different shifts during the course of one or two months, thus making the work and hours of all exactly alike in the cycle. At the end of each week the schedule is made up for the week to come, for each of the different classes of operatives interested, and this is posted on Saturday night so that as the men go off work on the following Sunday it is known what shift each will have during the coming week. These schedules are altered from week to week * * * to conform with the varying conditions of the load curve."

Thus, taking a typical day, the plant starts at midnight with five men—rather more in proportion than the day force, on account of the variable nature of the night load. At six the load begins to pick up, and the force is increased by one man each at six, seven, and eight o'clock, by which hour eight firemen are at work. This number is maintained until one o'clock, the noon drop being availed of for cleaning fires, eating dinners, and securing a breathing spell. Another man comes on at one, a tenth at two, and, anticipating the four o'clock maximum, three men come on at three and the last one at four, by which time fourteen are at work. "After five o'clock the load gradually declines until midnight, when it is only about one-fourth as high as it was at five. Owing to the way in which the men have been brought out, their shifts are finished so that the force is automatically decreased in proportion as the load decreases." Of course, the scheme as given above deals only with net changes, ignoring mere individual replacements not affecting the total number. Altogether twenty-one firemen have worked during the day, handling about 210 tons of coal, and the force arranged for gives at all times an excess of one or more men. The load curve and the "firemen's curve" for a specimen day show a really remarkable correspondence.

Next to providing the force comes its supervision. Mr. Abbott points out that study of the conditions of combustion in the furnace may easily effect a saving fourfold greater than can be made by final refinement of the indicator card. A fireman will normally burn fuel costing ten or fifteen times as much as his wages. By no sort of driving can half his wages be saved, but by proper watching and instruction he may easily be made to save double his wages in coal. The fuel itself should be selected to give "the greatest amount of combustible for the least amount of money, provided the furnaces are of the proper kind, and ample in capacity to make the required amount of steam." Next comes its proper combustion, and here the greatest aid may be given by the now easy process of flue-gas analysis, especially the determination of the percentage of carbon dioxide. Under perfect conditions, this may run up to 20 per cent.; in practice it often runs as low as 2 per cent.; of course, on account of excess of air through careless firing or through running the boilers on too light loads. Mr. Abbott has found great advantage from the use of the econometer, " a device * * * through which is induced a small current of gas from a boiler breeching. The weight of this gas, changing with its composition, moves a pointer across a dial." He gives some very interesting and amusing curves showing the close relations between boiler efficiency and carbon dioxide percentage, and the influence of surveillance upon firemen's efficiency.

The other points dealt with in his study are the saving and renovating of waste and the use and recovery of lubricating oil. For the former, he finds greatest advantage from the use of a good quality of waste, first on the finer parts of the machinery and then for coarser work. After this it is put through a washer consisting of a train of rolls over which hot water is running, and then dried in "a sheet-iron box 30 inches square and 6 feet high, filled with shelves one above another, made of wire netting and spaced about 10 inches apart," all being heated by a steam coil and relieved of vapor by a galvanized pipe leading to a boiler breeching. Two hundred pounds of damp waste can be dried thoroughly in a few hours. From 100 pounds oily waste, 40 pounds of oil and 40 pounds of dry waste are recovered. The issue of new waste is limited to three quarters of a pound per shift for a 1,200 horsepower engine, but the oilers are allowed all the washed waste they want. It is somewhat harsh and knotty, but more absorbent than new waste.

The recovered oil is purified by triple sedimentation, overflow, and drying. The admixture of cylinder oil makes it "better than new (lubricating) oil."

In cylinder lubrication, Mr. Abbott favors the adoption of "the oil which will give the best results in the high and let the low be content with what it gets."

As he says in his summary, some of these details may seem trivial, "but when we consider that $100 saved is $100 added to the surplus, which is as good as $500 increase in gross earnings, and that to add $500 monthly to the gross earnings would require an investment of, say, $25,000 * * * we may realize what a valuable asset is an engineer who is prolific in methods for keeping costs down or is ready to adopt such methods from others."

Foundry Management.

It is rather strange that while machine shop management has formed the subject of so much study and discussion, foundry management, comparatively speaking, has suffered from almost complete neglect. It is the more strange because very often shop and foundry form twin members of one plant. It is true that the United States affords examples of advanced foundry management, which seem to leave nothing to be added in the direction of system, economy, productiveness, or cheapening of output—witness the Westinghouse air-brake works at Wilmerding; but how often, on the other hand, the visitor to the American machine works of the first order is led from a machine shop full of the latest tools, operated by the most advanced methods, and ushered into the foundry with the apologetic remark, "Our foundry is very old-fashioned."

Mr. James A. Murphy's paper on Foundry Management, read before the American Foundrymen's Association and published in *The Iron Age,* deals with the matter very practically. The first prevailing fault he attacks is darkness. The "sunny side of an old oil torch" is a poor helper; "rough and bad castings can often be traced to bad light"; "light and ventilation are all important to success in the foundry." Mr. Murphy proposes, as a ready remedy, to have a section of the roof made of wire-glass, and by thus admitting daylight to avoid becoming "every day large and indirect contributors to the scrap pile."

He considers next labor and superintendence. The cursing, bulldozing foreman not only creates so much confusion about casting time that one-third of the work is likely to be lost, but drives away good men and incites time-killing among those who stay. "A man of broad experience, good education and address, temperate in habits and language, firm and polite in his demeanor, generally is a student of human nature and has executive ability of a broad-gauge character * * * and is sure to produce the very best paying results." Coming down to the molders, a very general source of loss is the morning hour spent pulling out castings, cutting sand, mixing facing, etc., and the other hours lost during the day "skirmishing around after gaggers, parting sand, rammers, brushes, riddles and fixing up old flasks that should have been fixed before the job was given out." Laborers should do all this work. The saving in wages thus to be made, in a foundry employing fifty molders, would pay a good foreman.

Materials—especially sand—are of great importance. "About the first thing a new molder will ask his partner when he starts in a shop is about the sand. If told it is bad, he invariably spends more time on his mold." And, with all the extra expense of time and labor, scabbing may occur. "The difference in price between good and bad sand is very little, but the difference in results, if figured up, would be astounding."

Drying should be better understood. It costs a little, but castings are rarely lost in dry sand, and "a better and stronger casting goes a long way in compensating for the little extra cost."

Great attention is paid to iron, and yet, after paying for good pig and devoting a lot of time to compounding mixtures, poor results often follow through failure to give attention to the quality of the fuel. Cheap facings are another expensive economy. It takes more time to slick up a mold with them—even if it can be done—castings are harder to clean, and on heavy work a bad job results from fused sand.

Tools receive Mr. Murphy's attention in closing. "To get the maximum amount of work, or to expect it, a man should have access to tools without looking around the shop for them or waiting till some one else is done. Every molder should have at least a good shovel, two riddles, a pail, a brush and a rammer." He should be held responsible for these, aided by assurance of discharge to anyone stealing them. The other things, clamps, gaggers, rods, weights, etc., which can be made with scarcely any expense to the shop, should be furnished in plenty, so no one would be tempted to hide them for safe keeping, or need spend valuable time hunting or waiting for them.

Broad views, system, and attention to the importance of apparently little things are as important to success in the foundry as they are elsewhere.

Mining Opportunities in Siberia.

The sensational gold discoveries in far northwestern America, and the rapid extension of American interests to the western shores of the North Pacific Ocean, have acted to turn the eyes of the mining world of the United States upon the yet unopened territory of Siberia, as possibly affording new worlds to conquer. In view of the diverse and often extravagant items of misinformation appearing in the daily press, it is of importance and value to secure information so definite and so conservative as that contained in the *United States Consular Report No. 754,* combining three documents relating to Siberian mining concessions. The first is a copy of the official communication to the Secretary of State from Count Cassini, Russian Ambassador, stating that the "exclusive right to exploit the mineral wealth in the Peninsula of Tchoukotsk" has been granted "to Colonel

Vonliarliarsky, of the Russian guards. The gentleman has organized an expedition under the direction of Mr. Bogdanovitch, a mining engineer, which sailed from Russia April 18-May 1." This expedition "is alone authorized to carry on mining operations in the country." The other two papers making up the report are communications from Commercial Agent Greener, at Vladivostock. They seem to be well informed, if not highly encouraging.

"Mining of all kinds in Siberia," Mr. Greener says, "has hitherto been beset with so many difficulties as to discourage operators, native or foreign. The concession to an American—D. M. Clarkson—to mine for gold or coal on his own account, without the usual adjunct of a Russian partner, seems to point to a more liberal policy. Still, there are restrictions." "Work must be done under disadvantages which would be hardly tolerable to ordinary American prospectors. For example, one must have special permits from local authorities for felling trees, and there are certain rules to be followed when minerals other than those specified in the grant are found."

The mineral wealth of the region has been for years practically untouched. "Much small capital has been exhausted in simply discovering that there is mineral wealth." The Chinese have worked and are still threshing over gold sands. Good specimens of coal are shown. Belgian, English, French and American experts have lately visited the country, and advised the formation of exploitation companies, but "prudent foreign companies withheld the capital, mainly because of government restrictions."

A coal bed 6 miles square lies only 31 miles from Vladivostock. It is an excellent quality of semi-anthracite, smokeless, valuable because of the marine market at Vladivostock. A French company tried to buy the mine in this area, but withdrew on account of the terms imposed. A similar result followed the efforts of the same company to buy a mine 16 miles from Vladivostock and 2.6 miles from the railway, where there is a basin of nearly 8 square miles of good steamship coal.

Several iron mines have been reported, lead and zinc are frequently found, and copper occurrences are plentiful, but no serious attempts at surveys have been made. Quartz gold mines on Askold Island, near Vladivostock, are worked to good profit by a Russian firm, but Mr. Greener thinks "it should be honestly said, without any disparagement to the future of Siberia, that it is no special place for Americans. Those who came here twenty-five to thirty years ago did well, but all had either Russian partners or married Russians and identified themselves with the country."

He gives some idea of the obstacles to be met in the following summary: "With regard to gold mining privileges, the applicant must make petition in person here, or he may go to St. Petersburg if more convenient. In the latter case, the imperial authorities would refer the matter to the governor general here before deciding the case. In no instance would such a permit be hastily granted, and an applicant without references as to character and ability to carry out his plans would undoubtedly be rejected. The government also exercises strict espionage in matters of passports, permits, etc., and there is a high tax on melting and conveyance from the mine to the government office."

"The government advances no money to miners or manufacturers of any kind, except to those coming within the scope of its administrative policy. It does assist immigrants after they have arrived, but does not pay their way. It buys the output of all mines, on broad grounds of governmental policy, as it controls mining business of whatever character. But this fact would afford little 'stability' to the venture of any American who came to Manchuria or the Maritime Province to engage in mining without a special permit, or a Russian partner, or a good supply of capital and abundant machinery."

Even more valuable is Mr. Greener's second communication, giving translation and condensation of a French compilation of the Russian laws on gold mining, accurate to 1898. He conceives it possible that some slight changes in the way of contemplated reforms may be already in operation, though he has no notice of them. Space permits only a few extracts:

"To acquire the right to prospect for either alluvial or quartz gold, all persons or companies must procure a special permit on stamped paper, issued by the department of mines. Permits contain no time limitations and are not transferable. A declaration in writing must be made to the police department of the locality where operations are proposed. The locality must be designated, as well as names of men belonging to the prospecting party, the date the expedition is to set out, and the place of departure. The passport and papers of each person must be accurately set forth. The cost of advertising the permit in the local press must be paid. In free territory, prospectors are entitled, so far as placer mining is concerned, to occupy an area of 5 versts (3.3 miles) in length, and in breadth the width of the valley in which operations are conducted; in quartz mining, to an area within a radius of 1 verst (0.663 mile) from a post bearing the date when prospecting began, and the name of the individual or company. After the post is set up, the right to prospect continues as long as the party stays on the tract so marked out. Should the ground be found sufficiently rich to be worthy of 'a request for a location,' at least two shafts must be sunk, demonstrating the presence of gold, and 'location posts' in place of the 'prospecting posts' must be set up.

"When a deposit is ascertained to be capable of being worked, a declaration of the fact must be made, in the form prescribed in paragraph 454, mining code (French edition), at the office of the chief of police in the district where the discovery is made. One copy of the declaration must be sent by the applicant for the location, within three months, without fail, to the chief office of mines, for publication in the local press; another copy goes to the district engineer, to be recorded in the register of applications for concessions. The copy sent to the chief office must be accompanied by a sum sufficient to pay expense of publication in the local press.

"In eastern, as well as in western, Siberia, the total length of a placer allotment must not exceed 5 versts (3.3 miles) in length, calculated from the 'indicator posts'; in breadth it may comprise the whole valley to the extent of 250 sagens (1,750 feet). An allotment granted for a gold bearing vein may be of any dimensions, provided its area does not exceed 1 square verst and the breadth is at least a third of its length.

"The same individual and company cannot receive two adjacent concessions; after one allotment has been obtained, a second cannot be granted except at a distance of at least 5 versts (3.3 miles) from the first. Holders of adjacent lots, however, are permitted to associate themselves into companies after the concessions have been granted.

"After the request for location has been granted the land may be cleared, the preliminary work undertaken, a more minute examination may be made, and actual working begun as soon as the documentary concession is in hand.

"The Russian mining code has two kinds of tax:

"(1) Land dues, calculated pro rata on the superficial area of the lot, payable from the date when the deeds granting the concession were received; due for the current year on December 31, and subject in case of nonpayment to the addition of a fine of 10 per cent.

"(2) Taxes in kind, based upon the amount of pure metal (gold or silver) extracted and deducted in the laboratories.

"In addition to the land dues and tax per pood (36.112 pounds), there is charged for the transportation of the gold to St. Petersburg: From Irkutsk, 46 rubles ($23.69) per pood; from Tomsk, 33 rubles $16.99). The conveyance of the gold in sealed sacks from the mines to the district office of the mining police and thence to the Department of Mines, is at the expense of the mine owner. In this province (Maritime), the charge is 150 rubles ($77.25) per pood.

"The operator must bear the cost of melting down the gold. The fee, by the new regulation of February 3, 1897, is uniform—42.315 rubles ($21.79) per pood of pure gold."

Mr. Greener, however, points out an opening for Americans in a line in which, as experience elsewhere has fully proved, they particularly excel: "The best chance for Americans here is in the line of mechanical work. A well-equipped machine shop, with competent American artisans and specialists in certain industries, would do well in Siberia; but no American without capital or special skill in his own trade has any business here."

Heavy Motor Vehicles.

The advantages of mechanical propulsion of goods-carrying vehicles are clearly so great—so much larger even than those of automobilism of pleasure carriages—that it seems strange that the light-passenger wagon should have been the one to develop the more rapidly.

It is perhaps due in part to the tremendous impulse given to personal transportation by the bicycle, and in part to the circumstance that results acceptable to seekers after novelty, sport, or luxury were possible of attainment sooner than those which must stand the most rigid comparative tests as to mechanical efficiency and commercial economy. However that may be, the passenger automobile is an accepted and rapidly-increasing institution and the greater interest of inquiry now seems to center in the lorry, or automobile wagon for heavy duty, in the development—or at least the use—of which the United States seem relatively backward. The *Scientific American Supplement* takes up the description of the principal competing lorries in the Liverpool Self-Propelled Traffic Association's trials, and Mr. Arthur Herschmann, mechanical engineer of the Adams Express Company, presented a paper at the recent meeting of the American Society of Mechanical Engineers, embodying data and conclusions reached in his study for that company of "The Automobile Wagon for Heavy Duty." Mr. Maynard's articles in our August and September issues give a comprehensive view of the British field.

Mr. Herschmann points out that many of the disadvantages urged by its opponents—danger in crowded streets, damage to road surfaces, smell, risk of accident—are fully as great, if not much greater, in the case of horse-drawn wagons. The automobile takes less space, is controlled by the single brain of the "driver," and (the nucleus of the entire question of safety) can be far more powerfully and surely braked. "A load of 3 tons on a motor wagon running at the speed of 8 miles, could be pulled up in 8 yards—a performance which could never be obtained with horses."

Mr. Herschmann then takes up the various propelling agencies, beginning with Ericsson and Tangye's steam wagons and following with electric, compressed air, oil-engine, and, finally, the newer steam-motor vehicles Electricity secures cleanliness, ease of operation, fair flexibility in power and speed conditions, and answers the requirements of smooth city roads; but on rough roads the punishment is heavier than the battery can stand, the dead weight is large ("the best traction cell has only a capacity of about 7 watts per pound of its weight"), battery maintenance is a serious item, and "at this phase of the evolution the battery makes the electric truck an impossibility."

Compressed air, with all its promise, still requires a revolution in the construction of light storage tanks; it has the disadvantage that pressure falls as the air is drawn from the storage tanks, and weight for weight is less readily adaptable than electricity.

Carbonic acid has similar defects, besides high cost. Illuminating gas, giving one horse power for each 18 cubic feet at normal pressure, would give larger radius of operation—the same quantity of air at 200 pounds' pressure being requisite for the same power; but it seriously complicates the mechanism.

Oil motors, Mr. Herschmann thinks, have as yet given "no important results" as regards freight vehicles. The inherent difficulties he defines as: lack of ample power in an emergency; a horse, at starting, is said to develop momentarily 14 horse power—some say even more; the oil motor will not start under load and cannot well be designed to vary in speed, at least not in a wide range; clutch and gear mechanisms are requisite for starting and for adapting it to the constantly varying speed requirements of the wagon, and these give rise to trouble on account of the impact of the moving masses. Non-reversible, it is by no means a flexible motor. Finally there is the evil-smelling exhaust, and (in goods service) the chance of damage therefrom.

The steam wagon he finds superior to its competitors because:

"1. It has the greatest load and mileage capacity, or, in other words, radius of action.

"2. Its operation is independent of charging stations, and supplies necessary for the operation of the wagon can be easily procured and taken aboard quickly."

With an electric wagon expense becomes prohibitive as soon as a certain ton-mileage is exceeded; the oil wagon has no such limitation, the objections being in difficulty of operation; the steam wagon is in an entirely different position, as "the weight of machinery to be carried does not grow even in an arithmetical ratio to the carrying capacity."

About one-half of Mr. Herschmann's paper is taken up with discussion of the construction, which can be only summarized by his conclusions, leaving the readers who are interested to consult the original paper for his argument. Rubber tires are unsatisfactory for commercial wagons designed to carry one ton or more; steel tires, properly applied to stiff wooden wheels, stand more work and strengthen the wheels; springs of ample proportions should be relied upon to lessen shock. The total width of tires in inches should be at least twice the number of gross tons, for small wagons (two tons net load), this coefficient of two diminishing to one or even less with very heavy wagons.

Small driving wheels are recommended by greater safety under the severe strains; otherwise larger wheels (4 foot instead of 3-foot) would be preferable, as giving "a more powerful starting torque" and saving the driving gear.

The advantages of front driving are "more than outbalanced by the disadvantages introduced in connection with awkward location of machinery." Steering by fifth wheel, while apparently better adapted for heavy work, is in reality not as satisfactory as steering with pivoted axle ends. Spur gearing is preferred to worm and worm-wheel, because it does not lock the gear and causes less strain on striking an obstruction. Great improvement is possible in connection with the compensating gear or Jack-in-the-box, linking the driven wheels. The transmission between engine and rear wheels can "only be reliably effected by means of accurate spur wheels immersed in an oil-bath. A speed-reduction gear, best provided by means of two sets of spur wheels of varying diameter, one set stationary, the other movable axially on a square shaft, forms a desirable adjunct to the mechanism."

Boiler desiderata are safety, small proportions, quick steaming, and economy. Preference is given to shell boilers. A superheating device, well applied, is of great advantage. In addition to the engine feed pump there should be a second steam-driven pump. The small injector has not yet been made to give satisfaction on a wagon.

Firing can be easily effected by an oil burner, but coal and coke are preferable and cheaper. Condensers are not approved. The difficulties connected with smoke have been quite overcome.

Compound engines have so far been universally used; a light, well-designed, quick-revolution engine, fitted with reversing gear and with means for admitting high-pressure steam to the low-pressure cylinder will always answer. The cylinder ratio should be larger than in stationary practice, as the pressure is higher and a large low-pressure cylinder means a powerful starting moment under live steam.

Generally speaking, Mr. Herschmann finds the wagons constructed far too light to stand the severe strain of their work. The cost of propulsion per gross ton is not so important as to warrant sacrificing durable construction. His paper is accompanied by designs of steam trucks and tables of operating costs, deadweights, and carrying capacities, and concludes with very practical suggestions regarding the separating of repair work from the actual operating or "driving" of the wagons.

Concrete Steel in Dry-Dock Building.

THREE years ago, when Mr. Foster Crowell was bringing out his articles on Modern Wharf Improvements and Harbor Facilities in this magazine, he made sharp comment upon the apathy which was responsible for the poverty of the United States in docking facilities.

Territorial and consequent naval expansion, and the revival of American ship building, which has been the topic of several articles in our recent issues, have concentrated much-needed attention on the improvement of docking facilities around the United States coast. Private enterprise is active—witness the work at Newport News referred to in our July number; and the prevailing interest is reflected in the current engineering press. *Engineering News* gives a large plate and a full, though condensed, description, from the *Annales des Ponts et Chaussées,* of the new Toulon dry dock with steel caisson foundations, and the

Engineering Record leads a recent number with an editorial on dry-dock construction, taking the Toulon dock and the great concrete dock at Liverpool as texts for a commentary upon the use of concrete and of concrete steel for dry-dock work.

The Toulon case is a quite remarkable instance of the use of the pneumatic caisson with dimensions far in excess of those usually employed. The underlying strata at the proposed site were two dissimilar layers of pudding stone, the upper, through which the excavation was to be made, being the softer, but quite intractable and permeable by water, and water-laden from inland drainage and from the harbor waters. Three plans were submitted by contractors: Excavation and masonry building in the clay, within a cofferdam—rejected because the authorities believed it would be impossible to deal with the seepage; use of ten smaller caissons—one for the entrance, one for the bottom and eight for the walls—considered favorably, but finally discarded because of belief that the many junctures would weaken the walls; and the single caisson plan, adopted and used. The caisson as first made was 492 feet long, 116.24 feet wide and about 59 feet deep. To this was later added an extension giving the dock a total length of 609 feet. The caisson was erected in a pit, which could afterward be connected with the sea so it could be floated out. It was then towed out, partially sunk, moved into position in the foundation pit, which had meantime been excavated by dredges, and brought to final depth, the filling in with concrete and the building up of the masonry not being remarkable except for the caution used in distributing the load so as to secure equal settlement and prevent distortion. Concrete found only partial application in this instance, but as the *Record* says: "It is a material admirably adapted to the requirements of dock construction. It can be made monolithic, and by a suitable combination with light steel members embodied in it, it possesses peculiar resisting qualities required by the reversal of duties to which a dock is subjected in the course of alternate filling and emptying. * * * The presence of steel gives a high tensile resisting capacity and a resulting beam strength, so to speak, that may readily eliminate the possibility of serious settlement cracks which would otherwise appear and produce grave doubts as to stability. This extension of the field of combined concrete and steel construction has not yet received much attention, but it cannot fail to take place."

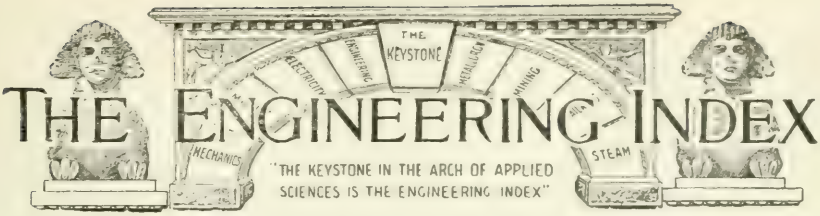
Novel Way of Installing a Shaft.

A SHORT paper by Commander Webster, U. S. N., in the *Journal of the American Society of Naval Engineers,* describes, by photograph almost as much as by text, the novel and interesting method employed in placing the propellor shaft in the United States torpedo boat Shubrick after she was afloat and without placing her in dry dock.

The Shubrick was built at Richmond, Va., at the yards of the Wm. R. Trigg Company, described in Mr. Fawcett's article elsewhere in this issue. As it became apparent, when she was otherwise completed, that long delay would occur before the shaft could be delivered by the contractors, and room on the ways was needed, she was launched without it in October, 1899, and so remained until March, 1900, when the installation of the shaft was undertaken.

The bow of the Shubrick was depressed by admitting about 22 tons of water into a forward compartment. Then a floating derrick having a hull 52 feet in length, 31 feet wide and 6 2-3 feet deep, drawing 2 feet and displacing 92 tons at normal draught, was brought around to her stern; ropes were passed under the hull and hooked to the tackle on the sheer legs, and the stern of the torpedo boat was lifted about 10 feet clear of the water. The angle of inclination of the scow under the load was almost exactly that of the hull of the vessel, rendering the work of placing the shaft comparatively simple. The extra load imposed on the derrick scow, including the partial weight of the torpedo boat and the weight of shafting, men and tackle, was 45 tons. The Shubrick is 175 feet long, and the distance from point of emergence to stern was 62½ feet, or more than one-third of her length.

Careful examination during this suspension showed no undue strain on framing or plating, and the fact that the shaft went into place without difficulty was evidence that there was no deflection.



THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCES IS THE ENGINEERING INDEX"

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst., Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Arch.

A Massive Foundation Arch. Illustrated description of very heavy 32-ft. brick arches supporting a part of a heavy building on the line of large water mains. 1200 w. Eng Rec—June 23, 1900. No. 34917.

Armory.

The Seventy-fourth Regiment Armory, Buffalo. Illustrated description of a 550 x 250-ft. armory, said to be the largest in the country. Special attention is paid to the details of the iron work, particularly the 227-ft. arch trusses of the drill hall. 2800 w. Eng Rec—June 9, 1900. No. 34662.

Builders' Methods.

Rebuilding the Kansas City Convention Hall. Illustrated description of the methods adopted in erecting with unusual rapidity the 187-ft. arch trusses of this building. 800 w. Eng Rec—June 23, 1900. No. 34916.

Chimneys.

Felling Tall Chimneys. Illustrates an effective and cheap method used in England. 1100 w. Sci Am—June 16. 1900. No. 34829.

The Chimney of the Metropolitan Street Railway Company's Power-House, New York. William Wallace Christie. Illustrated detailed description of the highest chimney in America. 1800 w. R R Gaz—June 8, 1900. No. 34639.

See also Mechanical Engineering, Steam Engineering.

Foundations.

See Arch, above.

Hospital.

Hospital Wall Construction. Illustrated description of special details arranged to prevent any accumulation of dust about the heating coils in wards. 600 w. Eng Rec—June 9, 1900. No. 34661.

Museum.

A Plan for Buildings on the "Kohleninsel" at Munich (Ein Entwurf zur Bebauung der Kohleninsel in München). Description and illustrations of very artistic museum, exposition buildings, etc., which it is proposed to erect on an island in the Isar River at Munich, abstracted from a memoir entitled "Die würdige Ausgestaltung der Kohleninsel und die Jubiläums-Ausstellung des Bayerischen Kunstgewerbevereins. Serial. 3 parts. 2000 w. Deutsche Bauzeitung—April 14, 18, 21, 1900. No. 34700 each B.

Roofs.

Some Comparisons of Graphic Statics Applied to Roofs. Henry Adams. Explanatory article of elementary work in graphic statics. 2000 w. Nat Build—June, 1900. No. 34935 C.

Retort-House Roofs. A. T. Walmisley. Read before the Incor. Gas Inst. A discussion of various types of roofs. Ill. Also general discussion. 8000 w. Gas Wld—June 16, 1900. No. 35016 A.

Roof Trusses.

The Calculation of Roof Trusses and Their Supports in Iron Structures (Die Berechnung der Binder und Ständer Eiserner Wandfachwerk). L. Geusen. A long mathematical article, with diagrams and tables. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—May 19, 1900. No. 34713 D.

Stresses.

Secondary Stresses in Framed Structures. Thomas A. Clark. A mathematical study of stresses and their strains. 1200 w. Engs' Year Book, Univ of Minn—1900. No. 35054 E.

The Bending Stresses in Flat Rectangular Concrete Floors. W. Dunn. Explains formulæ given in English books on applied mechanics, and gives a diagram for finding approximate maximum stresses on flat rectangular plates uniformly loaded. 2000 w. Jour Roy Inst of Brit Archts—May 26, 1900. No. 34864 B.

Wood Screws.

Holding Power of Wood Screws. W. M. Macphail and T. T. Irving. Read before the Can. Soc. of Civ. Engs. Tests made to determine the relation between the strength developed and the size of screw in different woods, both parallel to and across the grain. 2200 w. Prac Engr—June 1, 1900. No. 34801 A.

The Holding Power of Screws in Wood. Walter J. Graves. Describes tests and investigations made, giving general conclusions. 3000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35026 D.

HEATING AND VENTILATION.

Central Stations.

Central Heating Stations. Alton D. Adams. Information concerning heating systems for detached buildings, and for public supply. 2400 w. Munic Engng—June, 1900. No. 34542 C.

Explosions.

Explosions in a Hot-Water Heater. William J. Baldwin. A statement of their cause. 700 w. Eng Rec—June 2, 1900. No. 34541.

Hospitals.

An English System of Hospital Warming and Ventilation. Review of statement of present practice made by T. Wilson Aldwinckle before the Arch. Assn. of London. 800 w. Eng Rec—June 2, 1900. No. 34538.

Hot-Water System.

Hot Water Circulation. Robert W. King. Read before the Toronto Engs' Club. Illustrates and describes points to be met in designing an efficient hot-water heating apparatus. 4200 w. Can Archt—June, 1900. No. 34927 C.

Indirect Hot-Water Heating in a New York Residence. Illustrated description of a very extensive indirect system in which fans are provided for moving the air when the wind conditions are unfavorable. 1800 w. Eng Rec—June 23, 1900. No. 34919.

Schools.

Heating of the Indian School, Genoa, Neb. Illustrated description of a one-pipe steam heating plant for detached buildings. 1000 w. Eng Rec—June 2, 1900. No. 34539.

Some Features of New York School-Houses. Illustrated description of a double stairway in a single well, movable partitions, children's toilet rooms, and other features of buildings erected in 1899. 800 w. Eng Rec—June 16, 1900. No. 34858.

Ventilation and Heating of the Law School Building, University of Pennsylvania. Illustrated description of a system of warming by a heated supply of fresh air and ventilation on the plenum system, with numerous special details of construction. 3300 w. Eng Rec—June 16, 1900. No. 34856.

PLUMBING AND GAS FITTING.

Good Plumbing.

A Model Plumbing Installation. Illustrates and describes the apparatus in an engineering school to illustrate good plumbing practice and afford an opportunity for experiments of various classes. 1000 w. Eng Rec—June 9, 1900. No. 34663.

Power House.

Hydraulic Engineering in Metropolitan Power House. Illustrated description of the water supply and sanitary fittings of the Metropolitan power house in New York City. 1200 w. Met Work—June 30, 1900. Serial. 1st part. No. 34799.

MISCELLANY.

Buildings.

How to Study Buildings. C. H. Blackall. Suggestions for students traveling for the study of architecture, illustrating the process by examples. Ill. 6800 w. Archt Rev—May, 1900. No. 34597 D.

Derrick.

A Tower Derrick for Building Erection. Illustrated description of a special tower for handling material under exceptionally difficult conditions. 700 w. Eng Rec—June 16, 1900. No. 34859.

Fire Prevention.

The Prevention of Loss from Fire by Mutual Insurance. Editorial on a review of the development of mutual factory fire insurance in the United States, published by Edward Atkinson, discussing some of the causes of fires. 1700 w. Eng News—May 31, 1900. No. 34518.

Fire Tests.

Fire Tests with Floors. An illustrated account of an experimental fire test, made in England, with a floor of deal joists, with coke breeze concrete. 1300 w. Fire & Water—June 2, 1900. No. 34560.

Paris Exposition.

Architecture at the Paris Exposition of 1000 (Die Architektur auf der Pariser Weltausstellung des Jahres 1900). Albert Hofmann. A general descriptive and critical article, with illustrations and plans. Serial. 1st part. 2000 w. 1 plate. Deutsche Bauzeitung—May 26, 1900. No. 34702 B.

Terra-Cotta.

The Independence of Burned Clay as a Decorative Building Material. Herman C. Mueller. Read before the Am. Ceramic Soc. Also discussion. Considers its treatment and advantages. 2400 w. Brick—June, 1900. No. 34555.

CIVIL ENGINEERING

BRIDGES.

Arch.

New Double 140-Ft. Span Stone Arch Bridge for the Fitchburg R. R. at Bellows Falls, Vt. Illustrated description of the construction of one of the most notable stone arch railway bridges in America. 1100 w. Eng News—June 21, 1900. No. 34957.

The Bellefield Stone Arch Bridge, Pittsburg. Illustrated description of a masonry arch bridge of 150 ft. span and 85½ ft. width. 1300 w. Eng Rec—June 9, 1900. No. 34657.

See also Architecture, Construction.

Exposition Foot-Bridge.

Foot-Bridge Over the Seine Between the Pont de l'Alma and the Pont de Jena (Passerelle sur la Seine entre le Pont de l'Alma et le Pont d'Jena). Ch. Dantin. A well illustrated description of this steel bridge, of which the main span is a parabolic arch, and its construction and design. 4500 w. 1 plate. Génie Civil—May 26, 1900. No. 34750 D.

Inspection.

Bridge Inspection on the Erie Railroad. A statement of the organization for bridge inspection, the blanks used for the reports, and the directions to the inspectors. 1500 w. Eng Rec—June 2, 1900. No. 34537.

Lift Bridge.

A Rolling Lift Bridge at Cleveland. Illustrates and describes a Scherzer rolling lift bridge, of the single arm type, being built by C. C. C. & I. Ry. to replace an old wooden swing span. 900 w. Ry Age —June 8, 1900. No. 34653.

Plate-Girder.

A 128-Foot Plate-Girder Railroad Bridge. Illustrated description of its details and method of transportation and erection. 2000 w. Eng Rec—June 16, 1900. No. 34852.

Potomac Bridge.

The Prize Designs for the Proposed Memorial Bridge Across the Potomac River at Washington, D. C. Reviews the report submitted by the board appointed to examine the designs. 1500 w. Eng News—June 21, 1900. No. 34961.

Pratt Truss.

New Skunk River Bridge, C. B. & Q. Ry. Illustrated description of a double-track deck structure composed of three main spans of 146-ft. length, of the Pratt type, the trusses being 36 ft. 6 in. deep, bringing the track about 68 ft. above low water. 900 w. Ry & Engng Rev—June 9, 1900. No. 34697.

Steel.

The Proposed Specifications for Steel for Bridges, etc. H. R. Seaman. Considers the manufacturers' specification, criticising various clauses. 700 w. R R Gaz—June 22, 1900. No. 34974.

Swing-Bridges.

Reactions in Swing-Bridge Trusses. Willis Whited. Discusses the pier and abutment reactions in trussed draw bridges of both the center-bearing and rim-bearing types. 4000 w. Pro of Engs' Soc of W Penn—Feb., 1900. No. 34651 D.

The Duluth and Superior Bridge. Illustrated description of the truss and turning details of a very heavy swing span. 2500 w. Eng Rec—June 23, 1900. No. 34913.

The Spuyten Duyvil Swing Bridge; New York Central & Hudson River R. R. Illustrated detailed description. 1100 w. Eng News—June 14, 1900. No. 34885.

Viaduct.

Special Bridge and Viaduct Construction in Western Pennsylvania. Illustrated description of a 1,340-ft. bridge at Fort Perry carrying two tracks, but with one of the trusses proportioned to carry one-half the weight of a third track when a third truss is built alongside. The main 400-ft. span has very heavy details. 2000 w. Eng Rec—June 2, 1900. No. 34533.

Steel Footbridge Over the River Spree, Near Berlin, Germany. Illustrated description of the interesting features of an unusual design. 600 w. Eng News—June 14, 1900. No. 34881.

A Handsome Viaduct Over the Spree. Brief illustrated description of a very ornamental German viaduct. 400 w. Ry Age—June 1, 1900. No. 34617.

CONSTRUCTION.

Arch.

See Architecture, Construction.

See also Civil Engineering, Bridges.

Docks.

The Eastern Minnesota Ore Dock. Dwight E. Woodbridge. Illustrates and describes the largest iron ore shipping dock ever built and the largest piece of timber construction in the world. 1200 w. Ir Age—June 21, 1900. No. 34928.

Dry Dock Construction. A statement of the advantages of concrete-steel construction for dry-docks. 900 w. Eng Rec—June 16, 1900. No. 34847.

Dry Dock with Steel Caisson Foundations at the Port of Toulon, France. Two-page plate and description of a novel application of pneumatic steel caisson foundations. 2800 w. Eng News—June 7, 1900. No. 34687.

Pile Driving.

Hydraulic Pile-Screwing. C. W. Anderson, before the Inst. of Civ. Engs. Illustrating and describing water motors for screwing piles into hard material and giving results of work with these machines. 1700 w. Eng Rec—June 16, 1900. No. 34855.

Roads.

Road Building and Maintenance in France. Harry Fielding Reid. From the Maryland Geological Survey, Vol. III. Gives statistics of cost of construction and maintenance, describing the systems of inspection, maintenance and construction. 2200 w. Stone—June, 1900. No. 34874 C.

Stresses.

See Architecture and Construction.

Tunnels.

A Description of the Intersection of the Cataract Construction Company's Tunnels at Niagara Falls, N. Y. George F. Simpson. An illustrated detailed description of this work. 6500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35023 D.

Survey and Construction of the Cascade Tunnel by the Great Northern Railway Through the Cascade Range, State of Washington. M. E. Reed. An illustrated account of the work. 2400 w. Engs' Year Book, Univ of Minn—1900. No. 35052 E.

The Construction of the Turchino Tunnel. Illustrated description, from *Genio Civile,* of a 2,190-ft. tunnel driven in an unusual manner, which is explained in detail. 800 w. Eng Rec—June 2, 1900. No. 34536.

The East Boston Tunnel. Illustrated description of the double-track street-railway tunnel now being constructed under Boston Harbor by the Boston Transit Commission. 1000 w. Eng Rec—June 2, 1900. No. 34532.

HYDRAULIC AND WATER SUPPLY.

Austin Dam.

Soundings and Measurements at the Break in the Austin Dam. Thomas U. Taylor. Report of soundings made by the writer on June 9. Ill. 450 w. Eng News—June 21, 1900. No. 34962.

Speculations Suggested by the Austin Dam. W. R. Hutton. Letter discussing the effect of overflow on river bed below dam. 1000 w. Eng Rec—June 9, 1900. No. 34664.

Canals.

Canadian Canals and Trade. Editorial concerning the project for the construction of a deep-water canal from Georgian Bay to Ottawa and Montreal by way of Lake Nipissing and the Ottawa River, and the effect on traffic of the Great Lakes. 1600 w. Engng—June 15, 1900. No. 34989 A.

Methods and Results of Surveys and Borings for Oswego-Mohawk Ship Canal Route. D. J. Howell. Part first describes the methods of work, conditions, etc. 4200 w. Eng News—June 21, 1900. Serial. 1st part. No. 34958.

Croton Aqueduct.

The Preliminary Alinement of the New Croton Aqueduct. E. Sherman Gould. Gives details of some of the preliminary instrumental work connected with the location of the center line of the New Croton Aqueduct. 2200 w. Eng News—May 31, 1900. No. 34516.

Dams.

Investigation of the Distribution of Pressure on the Base of Dams, by Tests Made on an Elastic Model. F. F. Hall. Illustrated description of the apparatus used and method of experimenting, discussing results. 4000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35021 D.

See also Austin Dam, above.

Docks.

See Civil Engineering, Construction.

Drainage.

Run-Off of the Sudbury River Drainage Area, 1875-99, Inclusive. Charles W. Sherman. This watershed is one of the principal sources of the Boston water supply. Tabulated reports for the twenty-five years are given. 700 w. Eng News—May 31, 1900. No. 34520.

Dredges.

Experiences in the Operation and Repair of the Hydraulic Dredges on the Mississippi River. F. B. Maltby. Relates some of the experiences in the operation, the methods, results obtained, and repairs made necessary through wear. 4500 w. Jour Assn of Engng Socs—May, 1900. No. 35041 C.

Dredging.

The Bates Dredge for Calcutta. Illustrated description of a sea-going hydraulic dredge noteworthy for having the ladder for the suction pipe and cutter in a well-way in the center in the forward third of the hull. 2000 w. Eng Rec—June 9, 1900. No. 34660.

Filtration.

Mechanical Filtration. Edmund B. Weston. On the purification of water supplies by the use of sulphate of alumina in connection with the subsidence gravity system of mechanical filtration. Outlines the process, describing in detail and giving illustrations. Also discussion. 11000 w. Jour N. E. Water Wks Assn—June, 1900. No. 34499 E.

The Albany Water Filtration Plant. Allen Hazen. An informal talk at the Syracuse convention. Reviews the history of the supply, describes the plant, its construction and operation. Ill. 11000 w. Jour N. E. Water Wks Assn—June, 1900. No. 34498 E.

Flow.

Flow of Water Over Sharp-Crested Weirs. W. C. Parmley. Mathematical discussion of the manner of solving this problem. 4500 w. Wis Engr—June, 1900. No. 34863 D.

The Flow of Water Over Dams and Spillways. Editorial discussion of the lack of applicability of weir formulas for estimating the discharge over dams and spillways. 900 w. Eng Rec—June 2, 1900. No. 34530.

The Flow of Water Over Weirs. Gardner S. Williams. Describes methods of computing, investigations made, etc., considering the reliability of formulæ used. 3000 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35027 D.

Isthmus Canal.

Sea Level Canal Across the Isthmus of San Blas. William W. Redfield. Presenting the merits of this route, and giving information concerning it. Map. 4800 w. Jour Assn of Engng Socs—May, 1900. No. 35044 C.

The Nicaragua Canal—Hearing of the Commissioners. Editorial discussion of the report of the Commissioners before the Senate Committee. 2200 w. R R Gaz—June 1, 1900. No. 34573.

Laboratory.

Mount Prospect Laboratory. George C. Whipple. Illustrated description of the chemical laboratory, and the biological and chemical analysis of Brooklyn's drinking water. 6800 w. Sci Am Sup—June 30, 1900. No. 35067.

Lowell, Mass.

Lowell, Mass., and Its Water Supply. Extracts from the last annual report showing a flourishing condition from a financial standpoint. Ill. 500 w. Fire & Water—June 16, 1900. No. 34860.

Mains.

New Rising Main, Pittsburg, Pa. Illustrated description of a 48-inch riveted steel force main, 3,930 ft. long, with details of special connection, expansion joint and manholes. 1400 w. Eng Rec—June 9, 1900. No. 34658.

The Disinfection of Water Mains with Chloride of Lime. From the London *Surveyor.* Describes disinfecting the mains at Maidstone. Eng., after an epidemic of typhoid fever. 1000 w. Eng News—June 21, 1900. No. 34963.

New Orleans.

The Water Supply of New Orleans. John M. Ordway. States the conditions to be met and sketches a scheme for the supply of pure water to the city. 4000 w. Jour Assn of Engng Socs—May, 1900. No. 35042 C.

Pumps.

Test of a Twenty-Million-Gallon Pumping Engine. Gives the leading results of tests by R. W. Hunt & Co., of a vertical compound condensing flywheel engine at Omaha. 600 w. Eng Rec—June 16, 1900. No. 34857.

Reclamation.

Land Reclamation in Norfolk. Describes the system adopted, which makes the sea itself the maker of the land. 1500 w. Engng—June 1, 1900. No. 34811 A.

Reservoirs.

Recent Reservoir Construction, Worcester, Mass. Illustrated description of reservoirs with special spillways and aerating details. 700 w. Eng Rec—June 23, 1900. No. 34914.

River Pollution.

Improvement of the Mersey and Irwell Rivers. A review of the work accomplished in 8 years in keeping sewage and manufacturing wastes out of these streams. 900 w. Eng Rec—June 9, 1900. No. 34656.

The Conservation of the Thames. On the progress made in improving the general sanitary condition. 1800 w. Engr, Lond—June 1, 1900. No. 34819 A.

Water Supply.

Notes on the Relation Between the Geology of the Sources of Water Supply and Disease. Marsden Manson. Facts gathered while traveling on the Pacific coast. 2500 w. Jour Assn of Engng Socs—May, 1900. No. 35043 C.

Water-Works.

The Improvement of Spot Pond. Describes the method of cleaning and enlarging a natural pond of 296 acres to form a large distributing reservoir. 3000 w. Eng Rec—June 16, 1900. No. 34853.

The Monroe Suit for Defective Fire Protection. Review of an opinion by the Louisiana Supreme Court, holding a private company responsible for deficient fire protection under both a general franchise and special contracts with individuals, while refusing to hold the city liable under like conditions. 1200 w. Eng Rec—June 2, 1900. No. 34531.

The Mt. Prospect Laboratory of the Brooklyn Water-Works, Greater New York. George C. Whipple. Illustrated description of the building, and of the work carried on. 7200 w. Eng News—June 7, 1900. No. 34688.

The Water-Works of Crisfield, Md. Illustrated description of small works using air lifts for pumping wells. 1000 w. Eng. Rec—June 2, 1900. No. 34535.

Weirs.

See Flow, above.

MATERIALS.

Brick Piers.

Tests of Brick Masonry Piers. E. J. McCaustland. An account of tests made and results obtained. 2200 w. Trans of Assn of Civ Engs of Cornell Univ—1900. No. 35020 D.

Cement.

Cement Tests. A. S. Cooper. On the need of uniformity in testing, with critical remarks on method adopted by the Am. Soc. of Civ. Engs. and suggestions for improvements. 1500 w. Wis Engr—June, 1900. No. 34862 D.

The Michigan Alkali Co.'s Plant for Manufacturing Portland Cement from Caustic Soda Waste. B. B. Lathbury. Illustrated description of the interesting features of this plant, which uses lime waste from a caustic soda plant. Also editorial. 5700 w. Eng News—June 7, 1900. No. 34683.

The Proper Manipulation of Tests of Cements; a Symposium. Reviews the results given in the committee report of the Am. Soc. of Civ. Engs. of tests of hydraulic cement. 2500 w. Eng News—June 21, 1900. No. 34960.

Concrete.

Strength of Concrete with Different Per Cent. of Voids Filled. William A. Hawley and B. F. Krahl. Abstract of a graduation thesis. Report of a series of experiments made. 800 w. Eng News—June 7, 1900. No. 34684.

Timber.

A Proposed Method for the Preservation of Timber. F. A. Kummer. Condensed from a paper read before the Am. Soc. of Civ. Engs. Describes experiments made with a view of improving the creosoting process. Explains the reasons for the decay of timber, and considers the steps necessary to prevent it. 3200 w. Eng News—June 7, 1900. No. 34686.

The Strength of Timber, and How to Test It. This paper is based on a lecture delivered by Prof. Hudson Beare. Deals with the methods and modern experiments for the determination of the chief mechanical properties. 3500 w. Builder—June 2, 1900. No. 34800 A.

MUNICIPAL.

Garbage.

See Refuse, below.

Lighting.

Municipal Lighting Plants in Massachusetts. An analysis of the reports of 17 municipal lighting plants, giving costs of service to private consumers and for public lighting. 1100 w. Eng Rec—June 9, 1900. No. 34655.

Pavements.

What Pavements Do for a City. J. W. Howard. Extract from an address before the Board of Trade of Lowell, Mass. Notes some of the benefits of good pavements and their importance. 1800 w. Munic Engng—June, 1900. No. 34543 C.

Economics of Street Paving. S. Whinery. An outline of things to be considered in deciding upon a street pavement, with the investigations that should be made. 7300 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35025 D.

Refuse.

The Economical Disposal of Town Refuse. Brierley Denham Healey. Explains the various systems adopted for burning this refuse, and of utilizing the heated gases in such a manner as to make the process economical. Ill. 8300 w. Soc of Engs, Lond—May 7, 1900. No. 34526 D.

The Town's Refuse Problem. Concerning the constituents of refuse and the best means of disposal. 1600 w. Elec Rev, Lond—June 1, 1900. Serial. 1st part. No. 34804 A.

Garbage Reduction at Cleveland, O. Illustrated description of the system and plant. 1400 w. Eng News—May 31, 1900. No. 34517.

Sewage.

Recently Improved Methods of Sewage Disposal. Details of plants inspected and the results. 3300 w. San—June, 1900. No. 34525 D.

The Bacterial Treatment of Sewage. A discussion of this subject, the methods of application, and points of importance. 2800 w. Engr, Lond—May 25, 1900. No. 34604 A.

The Bacterial Treatment of Sewage. Frank Clowes. Discusses these processes and the experiences obtained from experiments, giving illustrations of some species of bacteria found in sewage. 3000 w. Nature—June 7, 1900. No. 34879 A.

Damages Due to Sewage Disposal in New York. A statement, largely quoted from a recent decision of the State court of final resort, outlining the remedies open to a property owner injured by the disposal of sewage from public sewers. 1200 w. Eng Rec—June 16, 1900. No. 34848.

Sewage Disposal at Sheffield, England. Gives the results of investigations with various methods of disposal, and the final recommendations for new works. 2100 w. Eng Rec—June 9, 1900. No. 34659.

The Manchester Sewage Disposal Experiments. Illustrated description of the bacteria beds, septic tank system and Roscoe filters used in 1898 and 1899, and their method of operation. 2600 w. Eng Rec—June 23, 1900. Serial. 1st part. No. 34915.

The Illinois River. A statement of the conflicting projects for its improvement, drawn up by U. S. engineers for navigation purposes alone, and by Chicago engineers to prevent floods due to the discharge from the Chicago drainage canal. 800 w. Eng Rec—June 9, 1900. No. 34654.

The Septic Tank System at Independence. Illustrated description of a number of septic tank and filter plants for different sections of Independence, Mo. 1000 w. Eng Rec—June 16, 1900. No. 34850.

Sewage Disposal.

See also River Pollution, under Hydraulic and Water Supply, above.

Sewerage.

Difficulties Encountered in Building the Storage Well for the Sewerage System of Concord, Massachusetts. Leonard Metcalf. Illustrated account of the essential features of the construction and some of the difficulties, the cost, etc. Discussion. 6000 w. Jour Assn of Engng Socs—May, 1900. No. 35040 C.

Sewers.

An Interesting Sewer Inspection. Describes the condition of an interesting sewer in Columbus, Ohio, after 6 years' service. 600 w. Eng Rec—June 16, 1900. No. 34849.

Cleaning Catch-Basins and Sewers. A. Prescott Folwell. Explains the methods and cost of such work in many American cities. 2500 w. Eng Rec—June 16, 1900. No. 34851.

Sidewalks.

Cement Sidewalks. W. K. Eldridge. Letter discussing reasons for failure of cement walks. 1800 w. Eng Rec—June 2, 1900. No. 34540.

MISCELLANY.

China.

The Coming Engineering Development of the Far East. Wm. Barclay Parsons. An admirable illustrated analysis of the characteristics displayed in native Chinese construction, and of the departments of engineering work in which there will be opening for Caucasian enterprise. 3000 w. The Engineering Magazine—July. No. 34756 B.

Hydrography.

The Survey of the Mouths of the Yukon River, Alaska. G. R. Putnam. An interesting illustrated account of the methods and of the information gained. 4500 w. Eng News—June 7, 1900. No. 34682.

Surveying.

Instructions for Surveying New York State Canals. A review of the rules formulated by the State engineer with the assistance of a board of consulting engineers. 3500 w. Eng Rec—June 16, 1900. No. 34854.

The Work of the United States Coast and Geodetic Survey. From the 67th Annual Report of the Survey, giving a brief historical summary of the work. 800 w. Eng News—June 7, 1900. No. 34685.

Government Surveys on the Ohio River. Describes methods employed in hydrographic surveys for river improvements costing $20,000,000. 2100 w. Eng Rec—June 30, 1900. No. 35104.

ELECTRICAL ENGINEERING

COMMUNICATION.

Address.

Mr. A. W. Heaviside's Presidential Address to the Newcastle-on-Tyne Local Section of the Institution of Electrical Engineers. Abstract. Reviews the history of the telegraph, telephone and other electrical industries and their position in Newcastle. 4800 w. Elect'n, Lond—June 8, 1900. No. 34898 A.

Cables.

A Practical Transmitter Using the Sine Wave for Cable Telegraphy; and Measurements with Alternating Currents Upon an Atlantic Cable. A. C. Crehore and G. O. Squier. Extracts from a paper read before the Am. Inst. of Elec. Engs.; also editorial. 5300 w. Elec Rev, N. Y—June 20, 1900. No. 34981.

Practical Examples of Simultaneous Testing, as Applied to Fault Localization in Submarine Cables. C. W. Schaefer. Describes applications of theoretic methods to actual work. 2700 w. Elect'n, Lond—June 8, 1900. No. 34899 A.

The First Submarine Cable. W. F. Bradshaw, Jr. An account of the cable laid across the Ohio River by John Boyd Sleeth, Ill. 800 w. Sci Am—June 23, 1900. No. 34954.

Electrical Waves.

Wave Transmission Over Non-Uniform Cables and Long Distance Air Lines. M. I. Pupin. Describes experimental investigation of a method of constructing cables and long-distance air-lines, particularly for long-distance telephony and telegraphy. 14000 w. Trans Am Inst of Elec Engs—April, 1900. No. 35050 D.

Switzerland.

Telegraphy and Telephony in Switzerland in 1899 (Telegraphen und Fernsprechwesen in der Schweiz im Jahre 1899). A full abstract of the official government report, with tables. Serial. 2 parts. 5000 w. Elektrotech Zeitschr—May 10, 17, 1900. No. 34726 each B.

Telegraphs.

Electro-Magnetic Mechanism with Special Reference to Telegraphic Work. R. A. Fessenden. Concerning the designing of electromagnetic mechanism; discussion of electrical units, equations of energy, etc. 3300 w. Jour Fr Inst—June, 1900. Serial. 1st part. No. 34646 D.

Imperial Telegraphic Communication. Sir Edward A. Sassoon. Reviews the history of cable communication between England and her colonies, and presents the present situation. Also discussion. 12500 w. Jour Soc of Arts—June 15, 1900. No. 34968 A.

Telegraphon.

The Poulsen Telegraphon or Magneto-Telephonograph (Rundschau). A description of this apparatus, in which a steel wire or ribbon travels before the magnet of a telephone receiver and has its permanent magnetism altered, so that when the wire is moved past another telephone the sounds will be reproduced. 1000 w. Elektrotech Zeitschr—May 17, 1900. No. 34727 B.

Telephones.

Telephone Development. Ed. L. Barber. Read before the Ind. Tel. Assn. A review of progress. 1400 w. W Elec'n—June 16, 1900. No. 34938.

Telephony.

Dr. Pupin's Improvements in Long-Distance Telephony. Herbert T. Wade. Illustrated description of investigations made, and their application to long-distance telephony. 2600 w. Sci Am—June 2, 1900. No. 34507.

The Possibility of Trans-Atlantic Telephony. An account of an interview with Dr. M. I. Pupin on his new system of cable construction. 800 w. Elec Rev, N. Y.—June 6, 1900. No. 34630.

Toll-Lines.

Toll-Line Traffic. J. B. Ware. Read at Cleveland meeting of the Ind. Tel. Assn. Considers toll rates and the division of the fees. 2500 w. W Elec'n—June 16 1900. No. 34937.

DISTRIBUTION.

Circuits.

On the Spark Due to the Break of an Electric Circuit. K. R. Johnson. Imagines an ideal circuit and deduces the true expression of the extra current of the break. 1000 w. Elect'n, Lond—June 15, 1900. No. 35004 A.

Short-Circuit Key.

Rymer-Jones Short Circuit Key. Illustrated description of a new form of short-circuit key. 800 w. Elec Rev, Lond—June 15, 1900. No. 35009 A.

Temperature.

On the Heating of Underground Electric Conductors (Ueber die Erwärmung Unterirdischer Elektrischer Leitungen). K. Wilkens. Theoretical considerations, and results of tests made on underground cables under normal working conditions in Berlin, with curves and tables. 2500 w. Elektrotech Zeitschr—May 24, 1900. No. 34733 B.

Three-Phase.

Mutual Inductance of Three Phase Circuits. Aug. J. Bowie, Jr. Discussing disturbances that arise and the means of overcoming them. Ill. 5300 w. Elec Wld & Engr—June 23, 1900. No. 34944.

Wire Protection.

The Protection of Insulated Wires. Frederick Bathurst. Critical review of articles by Sydney F. Walker. 1600 w. Elec Rev, Lond—May 25, 1900. No. 34615 A.

Wiring.

Notes on Conduit Wiring. H. H. Norris. Describes present practice and methods. 1200 w. Sib Jour of Engng—June, 1900. No. 35035 C.

ELECTRO-CHEMISTRY.

Advancement.

Advancement of Electrical Chemistry. F. Mollwo Perkin. Deals with electrolytic processes for obtaining the non-metallic elements and for the preparation of inorganic and organic compounds. 2600 w. Nature—June 7, 1900. No. 34880 A.

Errors.

Electro-chemistry. Wilder D. Bancroft. The importance of the study, showing the sources of error that may occur in carrying out any electrolytic process and the effect of slight variations. 3000 w. Sib Jour of Engng—June, 1900. No. 35037 C.

Hypochlorite.

The Electrolytic Production of Solutions of Hypochlorite for Bleaching and Disinfecting Purposes. John B. C. Kershaw. Describes electrolyzers for the production of hypochlorite now in use and the comparative costs. Ill. 2800 w. Elect'n, Lond—June 15, 1900. No. 35006 A.

Volta Effect.

The Volta Contact Force. On the deductions of Prof. Oliver Lodge, and the opposing opinions. 2500 w. Engng—June 1, 1900. No. 34812 A.

ELECTRO-PHYSICS.

Electrostatics.

Some Practical Features of the Electrostatic Field. Harris J. Ryan. Discusses the chief characteristics of the field, illustrating and describing phenomena and experiments, and showing the lines along which progress is being made toward rational insulation design. 6000 w. Sib Jour of Engng—June, 1900. No. 35039 C.

Interrupter.

A Current Interrupter (Stromunterbrecher). E. Grimsehl. An illustrated description of an interrupter consisting of a vibrating tongue, set in motion by compressed air, which makes and breaks contact with mercury. 700 w. Elektrotech Zeitschr—June 14, 1900. No. 34742 B.

A New Type of Mercury Interrupter. Eugene W. Caldwell. Illustrated description. 700 w. Elec Rev, N. Y.—June 20, 1900. No. 34980.

The Action of the Wehnelt Interrupter on Alternating Currents. George T. Hanchett. An explanation of effects observed while experimenting. 1300 w. Elec Wld & Engr—June 16, 1900. No. 34843.

GENERATING STATIONS.

Alternating Currents.

Alternating-Current Generators. H. G. Reist. Read at the Chicago convention of the Nat. Elec. Lgt. Assn. Traces the improvements made in alternating-current generators, describing the latest machines and their operation. Ill. 4000 w. Elec Rev, N. Y.—May 23, 1900. No. 34509.

Central Stations.

Central Stations in the South. W. S. Key. Illustrates and describes the Montgomery Light & Power Company's Central Station in part 1st. 1700 w. Elec Wld & Engr—June 9, 1900. Serial. 1st part. No. 34670.

Copenhagen.

The Vesterbro Municipal Electric Works at Copenhagen (Das Städtische Elektricitätswerk Vesterbro in Kopenhagen). C. G. Hoest. An illustrated description, partly abstracted from the Danish journal, *Ingeniören,* of this central station, which has Siemens & Halske dynamos and a large accumulator plant. 2500 w. Elektrotech Zeitschr—May 10, 1900. No. 34725 B.

Cut-Out.

Heavy Current Cut-Out Switch for Electric Railways and Power Plants (Starkstromausschalter für Elektrische Bahnen und Kraftübertragungen). An illustrated description of an automatic cut-out made by the "Helios" company. 500 w. Zeitschr f Klein u Strassenbahnen—May 1, 1900. No. 34705 C.

Dynamos.

Rotary and Direct Current Generators of the Lahmeyer Electrical Company at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Drehstrom und Gleichstromgeneratoren der Elektricitats-A.-G. vorm. W. Lahmeyer & Co., Frankfurt a. M.). An illustrated description of a 1000 k. w. rotary current generator and a 350 k. w. direct current generator. 500 w. Elektrotech Zeitschr—May 10, 1900. No. 34724 B.

3000 Kilowatt Rotary Current Dynamo of the Allgemeine Elektricitäts-Gesellschaft at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Drehstrom-Maschine von 3000 K W der Allgemeiner Elektricitäts-Gesellschaft). A brief illustrated description of this huge machine. 300 w. Elektrotech Zeitschr—May 17, 1900. No. 34728 B.

Economics.

Operating Economics in Central-Station Practice. W. L. Abbott. Read at Chicago meeting of the Nat. Elec. Lgt. Assn. Considers details of central-station operation and methods of reducing expenses. 4000 w. Elec Rev, N. Y.—May 30, 1900. No. 34616.

Electric Power.

The Cost of Electric Power Production. Philip Dawson. Considers what connection exists between the first cost of a plant and that at which power can be produced. 1400 w. Engng—June 1, 1900. Serial. 1st part. No. 34808 A.

Engine.

2500 H. P. Triple Expansion Engine and Direct-Connected Alternator at the Paris Exposition. Illustrated description of the general details of the engine and alternator installed at the Paris Exposition to provide current for lighting the buildings on the Champ de Mars. 1800 w. Eng News—June 21, 1900. No. 34959.

Isolated Plant.

Wakefield Asylum Electrical Installation. An installation embracing the lighting, heating and ventilating, and the electric driving of the machinery in the workshops and laundry is illustrated and described. 1800 w. Elec Rev, Lond—June 15, 1900. No. 35008 A.

Polyphase Motors.

The Design and Testing of Rotary Current Motors with the Aid of the Polyphase Motor Diagram (Ueber Entwurf und Prüfung von Drehstrommotoren mit Hülfe des Diagramms der Mehrphasen-Motors). Dr. M. Breslauer. A paper before the Elektrotechnischer Verein, giving the theory of polyphase motors and confirmatory tests, with diagrams, tables and curves. 6000 w. Elektrotech Zeitschr—June 7, 1900. No. 34739 B.

Power Plants.

The La Bella Power Plant, Goldfield, Colo. Illustrated description of a 3,600-H. P. plant built to supply electricity within a radius of 6 miles, compressed air within a radius of 2 miles, and water for ore washers near by. A number of interesting features concerning the distribution of air and the method of charging for electric current are explained. 2800 w. Eng Rec—June 2, 1900. No. 34534.

Pike's Peak Company's Power Plant.

J. W. Dickerson. Illustrated description of construction, pipe line, and equipment. 2400 w. Mod Mach—June, 1900. No. 34553.

Rotary Converters

A New Synchronizing Device for Rotary Converters. F. W. Springer. Illustrated description of the device and its operation. 800 w. Elec Wld & Engr—June 23, 1900. No. 34945.

Starting a Rotary Converter by Means of Direct Current Transmitted Over the Alternating Line. Frederick Bedell. An outline for a laboratory experiment. 300 w. Ill. Sib Jour of Engng—June, 1900. No. 35032 C.

Single Phase Motors.

The Resolution of the Oscillating Field of a Single Phase Motor into Rotary Fields (Ueber die Zerlegung des Oscillirenden Feldes des Einphasenmotors in Drehfelder). F. Eichberg. An article giving the theory, with confirmatory experiments on single phase motors. Diagrams and curves. 2000 w. Elektrotech Zeitschr—June 14, 1900. No. 34741 B.

Storage Battery.

The Storage Battery of the Sage Chapel Organ of Cornell University. H. H. Norris. States the problem to be solved and the troubles met. Ill. 1000 w. Sib Jour of Engng—June, 1900. No. 35-038 C.

Traction Power Plant.

Notes on American Corliss Engines for Electric Traction. Charles Day. A record of observations made during a visit of the writer to the United States for the purpose of studying the practice in regard to engines for electric traction. Ill. 1500 w. Engr, Lond—May 25, 1900. Serial. 1st part. No. 34605 A.

Engines for the Berlin Tramways. Illustrates and describes triple-expansion engines of the marine type, each group having one high, one intermediate, and two low pressure cylinders, arranged as twin vertical tandems coupled at 180 deg. with two fly-wheels. 1600 w. Engr, Lond—May 25, 1900. No. 34609 A.

Test of the Power Plant of the Buffalo Street Railway. R. C. Carpenter and H. J. Ryan. An outline of the test, explanation of its object, with summary of results and general information. 3800 w. Sib Jour of Engng—June, 1900. No. 35-029 C.

Transformers.

Current-Rushes into Transformers. R. C. Clinker. An explanation of the rush of current that often takes place through the primary winding at the instant of switching a transformer on to a live circuit. 800 w. Elect'n, Lond—June 15, 1900. No. 35005 A.

Eddy Current Losses in Transformers. Fitzhugh Townsend. Describes experiments made at Columbia University. 1800 w. Trans Am Inst of Elec Engs—April, 1900. No. 35049 D.

Tri-Phase.

The Central Station of the "Tri-Phase" Company at Asinères, Seine (Usine Electrique de la Compagnie "Le Triphasé" à Asnières, Seine). A very completely illustrated description of this large central station, which will furnish tri-phase currents to Paris. 4200 w. 4 plates. Génie Civil—June 9, 1900. No. 34754 D.

Wind Power.

Wind Power for Electrical Purposes. Roy E. Thompson. Describes the two general methods by which wind power may be applied to the generation of electrical energy. 1400 w. Engs' Year Book, Univ of Minn—1900. No. 35053 E.

HEATING AND WELDING.

Cast Weld Joints.

Cast Weld and Surface Contact Bonds. W. E. Harrington. Illustrated account of tests and results. 2000 w. Jour Fr Inst—June, 1900. No. 34644 D.

LIGHTING.

Arc Lamps.

Arc Lighting. Reviews the improvements made. 1000 w. Elec Rev, N. Y.—June 20, 1900. No. 34979.

On the Intrinsic Brilliancy of the Crater of the Arc. J. E. Pateval. An illustrated account of investigations. 2000 w. Elec Eng, Lond—June 8, 1900. No. 34934 A.

Public Arc Lighting in St. Martin's Parish, London. Illustrates and describes details of the work. 2500 w. Elect'n, Lond—June 1, 1900. No. 34803 A.

Carlisle, Eng.

Carlisle Electric Lighting. Charles D. Burnet. Read before a meeting of the Inc. Assn, of Munic. and Co. Engrs. Illustrates and describes the system, buildings, plant, etc. 2200 w. Elec Eng, Lond—June 8, 1900. No. 34933 A.

Lamp Cut-Out

Incandescent Lamp with Automatic Cut-Out (Glühlampe mit Selbstthätiger Stromunterbrechung). An illustrated description of an apparatus to be attached to an incandescent lamp, which will cut off the current automatically after the lamp has burned a fixed number of hours. 800 w. Elektrotech Rundschau—May 1, 1900. No. 34708 B.

Lamps.

High Efficiency Lamps for Isolated Installation. James Whitcher. Discusses the private supply of electric lighting through a battery of accumulators. 3000 w. Elec Rev, Lond—June 1, 1900. No. 34805 A.

Rating.

The Rating of Electric Lighting. Editorial discussion, and outline of the principles upon which the assessments are now made. 1500 w. Engng—June 8, 1900. No. 34904 A.

MEASUREMENT.

Dynamometer.

A New Transmission Dynamometer. W. Elwell Goldsborough. Illustrated description of the instrument and method of using it. 1800 w. Trans Am Inst of Elec Engs—April, 1900. No. 35047 D.

Electrometer.

The Electrometer in Theory and Practice. J. Warren. A study of the principles underlying its action. 2000 w. Elec, Lond—June 1, 1900. Serial. 1st part. No. 34802 A.

Faradmeter.

A Faradmeter. M. I. Pupin. Illustrated description; also discussion. 2500 w. Trans Am Inst of Elec Engs—April, 1900. No. 35045 D.

Instruments.

Electrical Measurement of Work and Energy. G. L. Addenbrooke. A clear and concise presentation of the principles, methods, and apparatus of electrical measurement, and of their importance in the study of mechanical economy. 4500 w. The Engineering Magazine—July, 1900. No. 34763 B.

Measuring Instruments of Precision for Alternating Currents of the Allgemeine Elektricitäts-Gesellschaft (Präcisionsinstrument für Wechselstrom der Allgemeinen Elektricitäts-Gesellschaft). Dr. G. Benischke. An address before the Elektrotechnische Verein, describing volt, ampère and watt meters, with illustrations; and the discussion ensuing. 4000 w. Elektrotech Zeitschr—May 17, 1900. No. 34731 B.

Meters.

Meters for Showing Conditions at Distant Points (Fernstromzeiger). Dr. Carl Michalke and Dr. O. Martienssen. An article describing a method by which, with the use of suitable connections, only one wire between two stations will enable the current consumption of each to be observed at the other. Diagrams. 1500 w. Elektrotech Zeitschr—June 7, 1900. No. 34738 B.

A Frictionless Motor Meter. S. Evershed. Describes an attempt to remove some of the defects of this particular class of meter, and the outcome. Ill. 8800 w. Brit Inst of Elec Engs—May 10, 1900. No. 34527 D.

Resistance.

A Percentage Bridge. Herschel C. Parker. Describes a method devised by the writer, useful in electrical laboratories. 900 w. Trans Am Inst of Elec Engs—April, 1900. No. 35048 D.

Testing.

Factory Testing of Electrical Apparatus. Arthur H. Ford. Describes methods of testing various kinds of apparatus. 4300 w. Wis Engr—June, 1900. No. 34861 D.

Volt-Hour Meter.

The Volt-Hour Meter of O'Keenan (Der Volt-Stunden-Zähler von O'Keenan). From a paper before the Société Internationale des Electriciens, at Paris, describing this meter and various uses to which it may be applied, with illustrations. 1200 w. Elektrotech Zeitschr—May 31, 1900. No. 34736 B.

POWER APPLICATIONS.

Accumulators.

See Mechanical Engineering, Automobilism.

Calender Driving.

A 50 Horse-Power Electromotor for Directly Driving a Calender Press (50 P S Elektromotor zum Direkten Antrieb eines Kalanders). K. Schindler. Illustrated description of a direct current motor for driving a 12-roll calender at highly variable speeds, with the controlling apparatus. 600 w. Elektrotech Zeitschr—May 17, 1900. No. 34729 B.

Electric Driving

Some Considerations Concerning Electric Driving. H. A. Mavor. Read before the Glasgow section of the Inst. of Elec. Engs. The probability of a large demand for motors and how the manufacturers are to meet it, the kinds of motors desired, etc. 2400 w. Elect'n, Lond—June 15, 1900. No. 35007 A.

Mining Machinery.

Electrical Coal-Mining Machines. Illustrates and describes the working of this type of coal-cutting machines. 1100 w. Sci Am—June 23, 1900. No. 34955.

Electrical Coal Mining Machinery. R. B. Blakeslee. Discusses mechanical engineering problems in the production of bituminous coal, including also problems of anthracite mining and coal cutting. 1700 w. Sib Jour of Engng—June, 1900. No. 35036 C.

Running Collieries Entirely by Electricity from One Center. Sydney F. Walker. Abstract of paper read before the Brit. Soc. of Min. Students. On economy possible by the use of the electric motor. 3000 w. Ir & Coal Trds Rev—May 25, 1900. No. 34611 A.

Swing-Bridges.

Working Swing-Bridges by Electricity. Describes various examples in the United States, where electrically operated machinery has been applied to these bridges.

Ill. 4700 w. Engr, Lond—June 8, 1900. No. 34909 A.

TRANSMISSION.

Snoqualmie Falls.

Snoqualmie Falls Power Transmission. Charles H. Baker. History of the enterprise, with an illustrated detailed description of the plant. 8000 w. Trans of Assn of Civ Engs of Cornell Univ—1900. No. 35019 D.

MISCELLANY.

Becquerel Rays.

Sources and Properties of Becquerel Rays. G. H. Bryan. A general account of a few of the more striking phenomena, including some of the recent developments. 4000 w. Nature—June 14, 1900. No. 34967 A.

Brushes.

The Best Proportions for Brushes with Collector Rings and Commutators (Die Günstigste Dimensionirung der Stromabuehmer bei Schleifringen und Kollektoren). G. Dettmar. A record of a very complete series of experiments on the contact resistance, pressure, dimensions, etc., of copper and carbon brushes, with curves and tables. 4000 w. Elektrotech Zeitschr—May 31, 1900. No. 34734 B.

Cable Factory.

The New Factory Buildings of the Siemens-Halske Company, near Berlin (Die Fabrikneubauten der Siemens & Halske A.-G. am Nonnendamm). C. Dihlmann. A well illustrated description of the new cable factory and brass foundry of the Siemens-Halske Co., on a large tract of land on the Spree. 3000 w. Elektrotech Zeitschr—June 14, 1900. No. 34740 B.

Experts.

Experts and Expert Evidence. J. E. Hindon Hyde. A discussion of the qualities a competent expert should possess. 5500 w. Trans Am Inst of Elec Engs—April, 1900. No. 35046 D.

Gutta-Percha.

The Future Supply of Gutta-Percha. Editorial on the increasing rise in the price of this product and its cause. 2800 w. Engng—June 8, 1900. No. 34903 A.

Lightning.

Destruction of Life and Property by Lightning. M. F. O'Reilly. Discusses the effect of lightning stroke and electric shock, giving statistics concerning the destruction of life and property and general information. 4500 w. Engng—June 15, 1900. No. 34985 A.

Paris Exhibition.

Electrical Engineering at the Paris Exhibition. Part first begins a general review of continental work as compared with English. 2500 w. Engr, Lond—June 15, 1900. Serial. 1st part. No. 34997 A.

Resistance.

Electrical Resistance of Thin Films Deposited by Cathode Discharge. A. C. Longden. A report of investigations. 1000 w. Am Jour of Sci—June, 1900. No. 34528 D.

Varying Voltage.

Dividing the Electromotive Force of Direct Current Dynamos by Means of Inductive Resistances (Spannungstheilung an Gleichstrommaschinen mittels Drosselspulen). Prof. A. Sengel. A mathematical treatment of methods of determining the difference in voltage in a divided circuit of a direct current machine; with results of tests and tables. Serial. 2 parts. 4000 w. Elektrotech Zeitschr—May 17, 24, 1900. No. 34730 each B.

X-Rays.

The Production of the X-Rays by a Battery Current. John Trowbridge. A successful new method of generating these rays and the advantage. 1200 w. Am Jour of Sci—June, 1900. No. 34529 D.

GAS ENGINEERING

Accounting.

Uniform Accounting for Gas and Electric Lighting Companies. James Blake Cahoon. Abstract of a paper read at Chicago meeting of the Nat. Elec. Lgt. Assn., and Editorial on "Uniform Accounting a Prerequisite to National Municipal Statistics." 3000 w. Eng News—June 14, 1900. No. 34884.

Acetylene.

See also Mechanical Engineering, Automobilism.

Some More Enemies of Acetylene. Further discussion of generators and the use of acetylene. 3200 w. Engr, Lond—June 1, 1900. No. 34818 A.

The Manufacture of Alcohol from Acetylene. A review of some of the methods, and the opinions concerning them. Ill. 2000 w. Eng News—May 31, 1900. No. 34519.

Address.

Inaugural Address before the Incorporated Gas Institute, England. E. Herbert Stevenson. Discusses the coal famine and the suggested amalgamation of the Institution of Gas Engineers and the Gas Institute. 5500 w. Gas Wld—June 16, 1900. No. 35013 A.

Analysis.

Determination of Benzene and Ethylene on Coal Gas. F. Haber. Abstract translation from the *Journal für Gasbeleuchtung*. Describes the method and manner of carrying out the researches. 2000 w. Jour Gas Lgt—May 29, 1900. No. 34692 A.

Candle Power.

Candle Power: Its Present Relation to the Gas Industry. John R. Lynn. Read before the Western Gas Assn. Also discussion. Considers the various uses of gas and the units of measurement in use, and the measuring of the term "candle power." 7700 w. Am Gas Lgt Jour—June 11, 1900. No. 34672.

Compressors.

Gas Compressors Actuated by Water Under Pressure. From *Revue Industrielle*. Illustrated description of the Keith gas compressor. 1300 w. Sci Am Sup—June 9, 1900. No. 34679.

Condensation.

Temperatures in Condensation. W. H. Barthold. Read before the Western Gas Assn. Also discussion. An account of experience at Grand Rapids, Mich. 5300 w. Pro Age—June 1, 1900. No. 34561.

Electrical Supply.

Electrical Supply by Gas Companies. Alton D. Adams. Discussing the advantages due to the development of the gas-engine. 1600 w. Sci Am—June 16, 1900. No. 34828.

Expert Evidence.

Some Disputed Points Among Gas and Water Experts. John Wilkinson. Read before the Incor. Gas Inst. Discusses the policy of experts when giving evidence. Also general discussion. 5000 w. Gas Wld—June 16, 1900. No. 35017 A.

Gas.

The New Gas. W. H. Y. Webber. Read before the Incorp. Gas Inst. Reviews the recent changes in gas manufacture and the uses to which gas is applied, and the development of the idea of utilizing the heating rather than the illuminating power, and so introducing incandescent gas, now so largely used. 9000 w. Gas Wld—June 16, 1900. No. 35015 A.

Gasholders.

The Guide-Framing of Gasholders. Abstract translation of a paper by Herr Hacker, of Berlin. Considers the uncertainty as to the distribution of the pressure of a wind on the ordinary guide-framing; three independent columns for guiding a gasholder; calculation of the ring 'round the crown, and of the forces transmitted to the columns; and the strain of the cups. Ill. 2700 w. Jour Gas Lgt—June 5, 1900. No. 34834 A.

Gas Plant.

The Plant of the Faribault Consolidated Gas and Electric Company. Oliver Field Allen. Illustrated description of a reconstructed plant. 3000 w. Engs' Year Book, Univ of Minn—1900. No. 35051 E.

Gas Works.

Monthly Technical Report of Operations in Coal Gas Works. W. E. Steinwedell. Read before the Western Gas Assn. Also discussion. Gives a form and suggestions. 4500 w. Am Gas Lgt Jour—June 11, 1900. No. 34671.

Hygiene.

The Hygienic Effect of the Use of Gas. Thomas D. Miller. Read before the Western Gas Assn. An account of investigations made and conclusions reached; also reporting investigations of others. Discussion. 4000 w. Pro Age—June 15, 1900. No. 34844.

Isolated Plants.

Gas-Plants in Large Buildings. Alton D. Adams. Suggestions as to the saving that could be effected by gas-engine and producer plants. 2000 w. Am Archt—June 23, 1900. No. 34941.

Mains.

The Systematic Location of Gas Mains and Other Pipes in the Streets as Opposed to the Popular Idea of a Subway. Donald McDonald. Read before the Western Gas Assn. Also discussion. Points out the objections to subways and outlines a plan considered less objectionable. Ill. 5400 w. Am Gas Lgt Jour—June 11, 1900. No. 34673.

Management.

Inaugural Address before the Association of German Gas and Water Engineers. W. von Oechelhaeuser. Deals principally with the social and moral obligations to workmen, the hygienic conditions, methods of work, etc. 6000 w. Jour Gas Lgt—June 19, 1900. No. 35082 A.

Manufacture.

Improvement in Gas Manufacture. Describes the process patented by John Coyne, of Pittsburg, whereby he asserts that 50,000 cubic feet of gas is secured from a ton of coal. Ill. 1400 w. Am Mfr & Ir Wld—June 14, 1900. No. 34-877.

Naphthalene.

Naphthalene from Retort to Point of Deposition. William Young. Shows the important part the crystalline condition of the naphthalene plays in producing troubles, and considers the remedies.

Discussion. 9800 w. Gas Wld—June 16, 1900. No. 35018 A.

Paris Exhibition.

The Gas Pavilion. Description of the building and its arrangement, and of the lighting of the exhibition, especially the lighting of the parks of the Champ de Mars by the Paris Gas Co. 3200 w. Jour Gas Lgt—May 22, 1900. No. 34613 A.

Rates.

Public Control of Rates. George McLean. Read before the Western Gas Assn. Also discussion. Considers it unjust and inexpedient on the part of public service corporations to oppose the principle of public control. 8000 w. Pro Age —June 1, 1900. No. 34562.

Retorts.

Automatic Stoking and Inclined Retorts. William R. Chester. Read at meeting of Incor. Gas Inst. The two successful systems of automatic stoking are considered and the successful development of inclined retorts. Also general discussion. Ill. 6500 w. Gas Wld—June 16, 1900. No. 35014 A.

Roofs.

See Architecture, Construction.

Technical Report.

Monthly Technical Report of Operation in Coal-Gas Works. W. E. Steinwedell. Read before the Western Gas Assn. Suggestions of system of recording operations and converting the data into proper form for reference. With discussion. 3500 w. Pro Age—June 1, 1900. No. 34563.

Temperatures.

Acetylene and Other Flame Temperatures. Edward L. Nichols. Read at meeting of the Am. Physical Soc. Description of apparatus used and observations. 5500 w. Pro Age—June 1, 1900. No. 34564.

MARINE AND NAVAL ENGINEERING

Battleship.

The Japanese Battleship "Asahi." Drawings and full description of the largest battleship afloat. 3500 w. Engng—May 25, 1900. Serial. 1st part. No. 34598 A.

United States Battleship "Georgia" and Class. Illustrated description. 1300 w. Sci Am—June 9, 1900. No. 34677.

Bilge Keels.

The Action of Bilge Keels. G. H. Bryan. Read before the Inst. of Nav. Archts. A theoretical discussion of the principles underlying the use of the bilge keels, showing that their efficacy in extinguishing roller motion is greater than would be directly inferred from experiments. 6500 w. Engng—June 1, 1900. No. 34813 A.

Cable Cutting.

Cable Cutting Operations of U. S. S. "St. Louis" during the Spanish War. Caspar F. Goodrich. An illustrated account of the work. 3400 w. Marine Engng—June, 1900. No. 34635 C.

Cable Ship.

The First German Cable Steamer, "von Podbielski" (Der Erste Deutsche Kabeldampfer "von Podbielski"). Joh. Schütte. An illustrated description of this new cable laying steamer and her engines. 1800 w. Zeitschr d Ver Deutscher Ing—June 9, 1900. No. 34722 D.

Commerce Destroyer.

The French Commerce Destroyer, "Guichen." Gives details of the American vessels of this class, and describes this vessel and the official trials. Ill. 1500 w. Engr, Lond—June 15, 1900. No. 34995 A.

Cruisers.

Contract Trial of the United States Protected Cruiser "Albany." Harold P. Norton and H. G. Gillmor. Illustrated detailed description of the vessel, with report of trials. 8400 w. Jour Am Soc of Nav Engs—May, 1900. No. 34647 H.

Protected Cruisers of the "Denver" Class for the U. S. Navy. Illustrated detailed description of these vessels and their equipment. 1800 w. Marine Engng —June, 1900. No. 34636 C.

Two Notable High-Speed Foreign Cruisers. Illustrates two of the latest high-speed cruisers built in European yards—the "Askold" and the "Chateaurenault." 1000 w. Sci Am—June 30, 1900. No. 35068.

Deutschland.

The German Express Steamer "Deutschland" (Der Deutsche Schnelldampfer "Deutschland"). An illustrated general description of this great steamer, of 23,000 tons displacement, 684 feet long and of 23 knots speed. 1300 w. Glaser's Annalen—May 15, 1900. No. 34744 D.

Dredge.

Self-Propelling Hydraulic Dredge for the Mississippi River. Two-page plate and description of a steel-hulled vessel fitted with side wheels, to be called the "Iota." Describes the tests to be made, as given in the specifications. 2800 w. Eng News—May 31, 1900. No. 34515.

Ferry Boat.

New East River Ferry Boat. An illustrated description of the "John Englis," recently launched. 1400 w. Naut Gaz—June 21, 1900. No. 34940.

German Exhibit.

Marine and Light House Exhibits at Paris (Die Weltausstellung in Paris. 1900. Schiffahrt und Kütsenbeleuchtung). A. Rudolph. An illustrated account of the German merchant marine exhibit at the Paris Exposition. Serial. 1st part. 1800 w. Zeitschr d Ver Deutscher Ing—June 9, 1900. No. 34721 D.

Ice Breaker.

The Ice Breaking Pilot Steamer "Haidamak" (Der Eisbrecher, Bergungs- und Lotsendampfer "Haidamak"). A very well illustrated description of the hull, engines, etc., of this Russian pilot boat, 187 feet in length, built at Kiel. 800 w. 1 plate. Zeitschr d Ver Deutscher Ingenieure—May 12, 1900. No. 34709 D.

Large Steamers.

List of German, English and American Merchant Steamers of over 10,000 Tons (Rundschau. Abmessungen der Dampfer der Deutschen, Englischen und Amerikanischen Handelsmarine). A table giving the principal dimensions of 19 German, 9 English and 3 American merchant steamships of over 10,000 tons. 500 w. Zeitschr d Ver Deutscher Ing—June 2, 1900. No. 34720 D.

Liners.

Mammoth Transatlantic Liners. A description of the "Ivernia" and "Saxonia," just added to the Cunard fleet. 2000 w. Naut Gaz—June 7, 1900. No. 34631.

Propeller Shafting.

A Novel Method of Installing Propeller Shafting. Harrie Webster. Describes the placing of the propeller shafting of the torpedo boat "Shubrick," with success and slight comparative cost, after the vessel was launched. 700 w. Jour Am Soc of Nav Engs—May, 1900. No. 34649 H.

Propellers.

How to Measure the Pitch of a Screw Propeller. Describes a method employed in Scotland. 500 w. Am Mach—June 21, 1900. No. 34923.

Improvements in Screw Propulsion. I. McKim Chase. Considers how to increase the efficiency of screw propellers. Ill. 1300 w. Marine Rev—June 21, 1900. No. 34943.

Relief Ship.

Relief Ship for India's Starving. Illustrates and describes the S. S. "Quito," now en-route to Bombay with 200,000 bushels of corn. 350 w. Marine Engng—June, 1900. No. 34637 C.

Sea-Power.

The Study of Sea-Power. Translated from *Marine Rundschau*. A scientific and historical study. 8000 w. Jour of U. S. Art—May-June, 1900. Serial. 1st part. No. 34551 D.

Sea Trial.

Description of a Full Speed Sea Trial. From the *London Globe*. Descriptive. 1500 w. Marine Rev—June 21, 1900. No. 34942.

Shell Fire.

Lessons from the Belleisle. Editorial on the experiments made to determine the effect of gun fire. Ill. 2000 w. Engr, Lond—June 15, 1900. No. 34998 A.

The Belleisle Experiments. An illustrated description of the effects of the firing and account of the damage. 3000 w. Engr, Lond—June 8, 1900. No. 34912 A.

Ship-Building.

The Ship Building Yards of the United States. Waldon Fawcett. A summary of conditions and progress, with statistics of work in hand and in prospect, and fully illustrated descriptions of all the larger yards of the country and of their equipment. Part 1. 5000 w. Ill. The Engineering Magazine—July, 1900. No. 34-757 B.

Cambering of Steamship's Keels. An account of an English high court decision in a case of special interest to naval architects. 2500 w. Marine Rev—June 28, 1900. No. 35081.

Shipbuilding in Germany. George Crouse Cook. Illustrates and describes Howaldtswerke at Kiel and the work 1200 w. Marine Rev—June 14, 1900. No. 34876.

Ship Building on Inland Rivers. Waldon Fawcett. Review of the work, showing a very promising outlook. Ill. 2200 w. Am Mfr & Ir Wld—June 7, 1900. No. 34695.

Unique Engineering Feat. Illustrates and describes the rapid work in cutting the steamship "Indiana" in two and pulling the sections apart 40 feet. 1000 w. Naut Gaz—June 14, 1900. No. 34846.

Shipping.

Shipping in Japan. Important facts relating to Japanese and foreign shipping. 1700 w. Engng—June 15, 1900. No. 34-990 A.

Steamer.

Magnificent Coastwise Steamer. Illustration and description of the new Boston and Portland Propeller, "Governor Dingley." 1300 w. Naut Gaz—May 31, 1900. No. 34521.

New Type Propeller Steamer. Illustration and description of the "Pennsylvania," a speedy inland passenger boat, in operation on Chesapeake Bay. 1900 w. Naut Gaz—June 28, 1900. No. 35080.

MECHANICAL ENGINEERING

AUTOMOBILISM.

See also Special Motors, below.

Accumulators.

The Construction of Electric Accumulators. The interest of the accumulator to the automobilist, and an account of its development. 3000 w. Auto Jour—June, 1900. No. 35058 A.

Acetylene.

Acetylene and Its Adaptability as a Motive Power for Vehicles. E. C. Oliver. Reviews the history of acetylene, its manufacture, properties, etc., and discusses its use in motors. 2400 w. Horseless Age—June 20, 1900. No. 34947.

Some Properties of Acetylene. Herbert L. Towle. Considers generators, reports tests, etc. 2700 w. Horseless Age—June 20, 1900. No. 34950.

The Accumulators of Acetylene. From *Echo des Mines.* Methods of storage and transport are considered. 800 w. Horseless Age—June 20, 1900. No. 34953.

Will Acetylene Be the Coming Power for Motor Vehicles? D. N. Long. Presents the advantages for power purposes thus far demonstrated. 1800 w. Horseless Age—June 20, 1900. No. 34948.

Charging Stations.

Electric Automobiles in Boston. An illustrated account of the work and experience of the New England Electric Vehicle Transportation Company. 2300 w. Elec Wld & Engr—June 16, 1900. No. 34842.

Competitions.

Motor Car Competitions in France. G. Forestier. Reports two competitions, showing conveyances can now be propelled by mechanical power with greater economy than by horses. 1200 w. Am Mfr & Ir Wld—May 31, 1900. No. 34574.

Fuels.

Acetylene and Alcohol Versus Gasoline as Fuels. Isaiah L. Roberts. A comparison of the value of petroleum, acetylene and alcohol as fuels for use in the propulsion of self-moving vehicles by explosion in the cylinders of their engines, and use as a fuel to generate steam. 2000 w. Horseless Age—June 20, 1900. No. 34946.

Acetylene and Gasoline. L. Berger. A comparison. 600 w. Horseless Age—June 20, 1900. No. 34951.

On some French Experiments on Acetylene and Alcohol as Motor Fuels. P. M. Heldt. Discusses the cost and calorific power. 2000 w. Horseless Age—June 20, 1900. No. 34949.

Generators.

Acetylene Generators for Motor Vehicles. W. F. Cooper. Discusses the classes of generators used. 1000 w. Horseless Age—June 20, 1900. No. 34952.

Horseless Carriages.

Automobiles for the Average Man. Cleveland Moffett. Facts about horseless carriages, with their advantages and their disadvantages. Ill. 3800 w. Rev of Revs—June, 1900. No. 34549 C.

Locomotion.

Modern Locomotion. David Solomons. Excerpt from a paper before the Anglo-French Assn. Concerning motor cars, the power, steering mechanism, and other points. 3000 w. Auto Jour—June, 1900. No. 35061 A.

Motive Power.

The Automobile. R. H. Thurston. A discussion of the types of motor, finding use at present, the cost of operation, rated powers, etc., and statement of points proved in its construction and use. 13800 w. Sib Jour Engng—June, 1900. No. 35034 C.

Motor-Carriage.

A New German Motor Carriage. Illustrates and describes a vehicle designed by Vollmer for ascending heavy grades regardless of the character of the road. 800 w. Auto Mag—June, 1900. No. 34546 C.

Motor Cars.

The Manufacture of Motor Cars. The harm to the industry from the lack of technical education by many taking up this work. 1700 w. Auto Jour—June, 1900. No. 35060 A.

Paris Cabs.

Electric Cab System of Paris. Illustrated description of the cab adopted, and the electric plant for charging the batteries. 1500 w. Sci Am—June 2, 1900. No. 34506.

Paris Exposition.

Automobile Conveyance in the Interior of the Exposition. Brief illustrated description of the rolling platform and the electric railway. 1600 w. Auto Mag—June, 1900. No. 34544 C.

Motor Cars at Vincennes. Brief account of the trials of touring vehicles. 1500 w. Engr, Lond—May 25, 1900. No. 34607 A.

Progress.

Trend of Progress of the Automobile. R. H. Thurston. Part first considers the design, running gear, type of motor, etc. 1600 w. Auto Mag—June, 1900. Serial. 1st part. No. 34545 C.

Trials.

Proposed Trials of Motor Vehicles. Gives the programme of trials to be held in June, 1901, by the Liverpool Self-Propelled Traffic Assn. 1800 w. Engr, Lond—June 15, 1900. No. 34999 A.

HYDRAULICS.

Turbines.

Turbine Construction (Die Weltausstellung in Paris 1900 Turbinenbau). Prof. E. Reichel. A general review of turbine construction and the present state of the art; with references to some of the exhibits at Paris. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34714 D.

MACHINE WORKS AND FOUNDRIES.

Brass.

Brass Founding—Gates and Gating. C. Vickers. Illustrated description of a good method of gating a mold. 1400 w. Am Mech—June 28, 1900. No. 35064.

Brass Furnaces. Paul Wever. Particulars concerning furnaces in use on the continent of Europe, but little known in the United States. Ill. 1800 w. Foundry—June, 1900. No. 34547.

Cams.

Analysis of the Cams of the Geometric Boring Tool. J. B. Taylor. Explanatory notes. 1100 w. Am Mach—June 14, 1900. No. 34826.

Castings.

Open-Hearth Steel Castings. E. C. Wheeler. Reviews the advances made in this industry and the uses to which the castings are applied. 3700 w. Ir Trd Rev—June 14, 1900. No. 34836.

The Mixing and Melting of Iron for Hydraulic Work. R. G. Cunningham. Read before the Am. Found. Assn. Considers the effects of constituents of iron upon castings. 1800 w. Ir Age—June 7, 1900. No. 34619.

Conveyors.

Conveyors in the Foundry. Dr. R. Moldenke. Reviews the uses for which the apparatus is adapted in foundry work. 1500 w. Ir Trd Rev—June 14, 1900. No. 34837.

Crane-Hooks.

Crane Hooks. C. F. Blake. Describes a method applicable to any short piece of mechanism eccentrically loaded, whether in tension or compression. 800 w. Am Mach—June 14, 1900. No. 34827.

Cranes.

Cranes. See Power and Transmission, below.

Drawing Office.

Drawing Office System of the Bullock Electric Manufacturing Company. W. H. Warren. Describes some features of the room and its furnishings, and the system used. 3800 w. Am Mach—June 7, 1900. No. 34690.

Founding.

Training Students in the Principles of Founding. Thomas D. West. Read at the Chicago meeting of the Am. Found. Assn. On the desirability of colleges training in this art. 2500 w. Ir Trd Rev—June 7, 1900. No. 34669.

The Properties and Uses of Logarithmic Cross Section Paper. J. A. Brown. An explanation of the manner in which results are obtained and the uses to which it may be applied. 1600 w. Am Mach—June 21, 1900. Serial. 1st part. No. 34920.

Foundry Chemists.

The Training of Foundry Chemists. Edward Kirk. Read at the Chicago meeting of the Am. Found. Assn. Also discussion by Thomas D. West, and communication from Robert H. Richards. 3600 w. Ir Trd Rev—June 28, 1900. No. 35070.

Fuel.

The Real Fuel Ratio. L. C. Jewett. Read at Chicago meeting of the Am. Found. Assn. Discusses what takes place in an effort to reduce the fuel ratio, and gives a table based on heats of 20 tons a day and coke at $4 a ton. 800 w. Ir Trd Rev—June 21, 1900. No. 34925.

Gears.

A System of Cutting Bevel Gears with Rotary Cutters. Herbert Innes Jacques. Illustrates and briefly describes a method by means of which bevel wheels may be cut, it is believed, with the nearest approach to accuracy obtainable with rotary cutters. 1700 w. Am Mach—June 7, 1900. No. 34689.

Cutting Spiral Gears on the Lathe. George R. Martin. Illustrated description of the work. 400 w. Am Mach—June 21, 1900. No. 34921.

Ingots.

Ingots for Gun Tubes and Propeller Shafts. F. J. R. Carulla. Read before the Iron and Steel Inst. Reports experiments made and discusses the forms found to best answer the required conditions. 1200 w. Col Guard—June 1, 1900. No. 34817 A.

Labor.

Settlement of the Machinists' Strike in the United States. Full text of the agreement reached by the arbitrators, with editorial pointing out its influence for lasting harmony, and explanation of variations between the official document and one put forth by the men. 2300 w. The Engineering Magazine—July, 1900. No. 34759 B.

The Official Agreement of the Arbitration Board. Text of the resolutions adopted. 1500 w. Am Mach—June 28, 1900. No. 35062.

Lathe.

A Spindle-Lathe with 150 Millimeters Height of Centers (Leitspindelbank von 150 mm Spitzeuhöhe). C. Schalz. A very well illustrated description of a metal lathe having a bed of the American pattern in general, but with various modifications. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34715 D.

Milling Machines.

More Early Milling Machines. E. G. Parkhurst. Illustrates and describes the first improvements made in these machines. 1300 w. Am Mach—June 28, 1900. No. 35063.

Oil Slings.

The Design of Oil Slings. Edwin Rust Douglas. Describes experiments made to find the cause of failure in devices used and to determine the preventive. 1000 w. Am Mach—June 21, 1900. No. 34922.

Pipe Founding.

Some Notes on Pipe Founding. E. Kebler. Read before the Foundrymen's Assn, England. Illustrated description of modern practice. 1600 w. Ir & Coal Trds Rev—May 25, 1900. No. 34610 A.

Sheet Metal.

Pressure and Power Required to Roll Sheet Metal. W. P. Richardson and E. K. Wennerlund. Experiments described were made to determine the pressure required to reduce various metals, by cold rolling, and to measure the power absorbed by the rolling-mill, and the difference when provided with roller bearings. 1800 w. Engs' Year Book, Univ of Minn—1900. No. 35056 E.

Shop Lighting.

Artificial Light, with Special Reference to Engineers' Shops. A. E. A. Edwards. Read before the Birmingham (Eng.) Assn. of Mech. Engs. Considers the reflecting power of various surfaces and colors, shades, height, different illuminants, etc. 4200 w. Gas Wld—June 2, 1900. No. 34806 A.

Shops.

Gothic Works, Norwich, England. Illustrated description. 1700 w. Engr, Lond—June 8, 1900. No. 34911 A.

The New Erecting Shop of the H. K. Porter Company. Illustration, plan and brief description of a shop having longitudinal tracks served by overhead cranes. 250 w. R R Gaz—June 22, 1900. No. 34970.

The New Mechanical Engineering Shops of the University of Minnesota. J. J. Flather. Description with plans. 700 w. Engs' Year Book, Univ of Minn—1900. No. 35055 E.

Shop System.

Another Shop System. A. L. Graffam. Explains the foundation of a system adapted to machine tool building, special machinery and jobbing. 3000 w. Am Mach—June 28, 1900. No. 35066.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Part 2 of Prof. Diemer's series deals with the production department bills of material. He discusses the listing of material and tools. forms for bills of material, services and record, the duties of material clerks and the cheapening of manufacture by duplication. 3000 w. The Engineering Magazine—July, 1900. No. 34758 B.

Foundry Management. J. A. Murphy. Read at the Chicago meeting of the Am. Found. Assn. Discusses true and false economics, materials, tools, etc. 2500 w. Ir Age—June 14, 1900. No. 34833.

MATERIALS OF CONSTRUCTION.

Boiler Plates.

Open-Hearth Steel Boiler Plates. T. L. Coudron. A comparison of the specifications proposed by the Am. Committee of the Inter. Assn. for Testing Materials with the Standard Specifications of the Am. Ry. Mas. Mechs.' Assn and others. Also editorial. 3500 w. R R Gaz—June 22, 1900. No. 34971.

Crystallization.

Crystallization of Metals. Edward B. Gilmour. Presented at the Chicago meeting of the Am. Found. Assn. Incidents from the writer's experience, and suggestions helpful to molders. Ill. 1100 w. Ir Age—June 14, 1900. No. 34832.

Lead.

Ornamental Lead and Lead-Casting. F. W. Troup. Read before the Birmingham (Eng.) Archt. Assn. Historical review, quoting from various authors, with illustrated description of work. 10000 w. Jour Roy Inst of Brit Archts—May 12, 1900. No. 34618 B.

Pig Iron Fracture.

Indications of Fracture in Pig Iron. Edward Kirk. How the chemist can utilize knowledge of fracture indications. 1700 w. Am Mfr & Ir Wld—June 21, 1900. No. 34976.

MEASUREMENT.

Econometer.

Arnett's Gas Weighing Econometer. A. Bement. Report of its value as a guide for managing fires and other uses, by a writer who has had experience with the instrument. 900 w. Sib Jour of Engng—June, 1900. No. 35031 C.

Manometer.

Notes on Lead Smelting and Gold and Silver Refining. Malvern W. Iles. Illustrated description of an instrument devised by M. S. Fallis, in which the pressure is balanced by gravity. 1800 w. Eng & Min Jour—June 30, 1900. No. 35078.

Pyrometers.

Practical Experience with Pyrometers. William H. Zimmer. Read before the Am. Ceramic Soc. Records the writer's experience with Seger cones and the Le Chatelier pyrometer. Also discussion. 7500 w. Brick—June, 1900. No. 34556.

Some Registering Apparatus for the Registry of High Temperatures. Albert Granger, in *La Ceramique.* Illustrated description of several instruments but slightly known. 900 w. Brick—June, 1900. No. 34557.

POWER AND TRANSMISSION.

Bearings.

Hot Bearings. H. Rolfe. The paper deals with causes of heating in detail. General discussion follows. Ill. 35000 w. N. Y. R R Club—May 17, 1900. No. 35028.

Compressed Air.

A Diagram for Solving Compressed Air Problems. J. A. Brown. Explanatory. 900 w. Am Mach—June 26, 1900. No. 35065.

Some Notes on the Compression of Air. E. C. Sickles. Personal experience with the practical operation of air compressors. 1700 w. Sib Jour of Engng—June, 1900. No. 35033 C.

Cranes.

Cranes at the Paris Exposition of 1900 (Die Weltausstellung in Paris 1900. Hebemaschinen). H. Kammerer. A general description of cranes, windlasses and other hoisting machines at the Exposition, with a table and plan. 1800 w. Zeitschr d Ver Deutsche Ing—May 19, 1900. Serial. 1st part. No. 34712 D.

The 30-ton Electric Crane in the French Section of Machinery Hall, Paris (Grue Titian Electrique de 30 Tonnes de la Salle des Machines La Bourdonnais). Alfred Boudon. A well illustrated description of this large traveling cantilever crane. 1500 w. 1 plate. Génie Civil—May 19, 1900. No. 34749 D.

Fly-Wheel Accident.

The Breaking of a Fly-Wheel (Ueber den Bruch eines Schwungrades). H. Hagens. An illustrated description of a fly-wheel accident in an electric power station at Königsberg, Prussia. 600 w. Zeitschr d Ver Deutscher Ing—May 12, 1900. No. 34710 D.

Gears.

Inertia Stress of Electric Gears. J. H. Macalpine. A statement of the problem, investigations made, methods used, etc. 13600 w. Jour Am Soc of Nav Engs—May, 1900. No. 34650 H.

The Strength of Gear Teeth. Robert A. Bruce. An investigation based on equation given in paper of Wilfred Lewis. 2000 w. Am Mach—May 31, 1900. No. 34513.

Pneumatic Tubes.

Pneumatic Transmission in Underground Tubes. Harrison Stidham. Reviews the history of pneumatic transmission, and describes the present practice in New York City and some of the problems encountered. Ill. 10500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35024 D.

Power Plants.

The Design of Steam Power Plants. Henry C. Meyer, Jr. Introduction to a series of articles on power-plant design, outlining the considerations governing the location of plants, and the methods of purchasing apparatus. 3600 w. Eng Rec—June 23, 1900. Serial. 1st part. No. 34918.

Rock-Drill.

The Gas Rock-Drill. Description given by Mr. Consul Powell in his report on the trade and commerce of Philadelphia. 1200 w. Col Guard—June 8, 1900. No. 34907 A.

Windmills.

Windmill Power. E. C. Murphy. Illustrates and describes types of windmills, notes some uses to which they may be applied, and gives data from experimental tests. 2500 w. Trans Assn of Civ Engs of Cornell Univ—1900. No. 35022 D.

SPECAL MOTORS.

Blast-Furnace Gas.

Utilization of Blast Furnace Gas in Engines. Emile Demenge. From a lecture to the Société Industrielle de l'Est de la France. Observations on the quality and quantity present and future utilization, principal engines used and blowing engines. Ill. 5000 w. Col Guard—May 25, 1900. No. 34602 A.

Gas Engines.

A Central Station Electric Plant Operated by a Gas Engine. J. C. Small. Read before the Western Gas Assn. Experience of the writer, with suggestions. Also discussion and letters on this subject. 4800 w. Pro Age—June 15, 1900. No. 34845.

The Efficiency of the Gas Engine. Ed. C. de Segundo. A comparison of the efficiency of the gas engine and steam engine, and an explanation of what is meant by "efficiency" as here used. 1200 w. Elec Rev, Lond—June 15, 1900. No. 35012 A.

Gas Engine Tests.

Test of Large Cockerill and Westinghouse Gas Engines. R. A. Millar and C. S. Gladden. An account of tests of two engines of exceptionally large power, with principal results. 2000 w. Sib Jour of Engng—June, 1900. No. 35030 C.

Heat Engines.

The Imperfections of the Cycles of Heat Motors. The "Economical Motor" (Imperfections des Cycles des Moteurs Thermiques. Le "Moteur Economique"). O. Duperrow. A general discussion of the theory of heat engines, with special reference to a type invented by the author, in which he endeavors to combine the advantages of steam and gas engines. Serial. 2 parts. 6000 w. Génie Civil—May 26, June 2, 1900. No. 34751 each D.

Heat Utilization.

Utilizing the Waste Heat from the Gas Engine. Alton D. Adams. An analysis of the heat-losses and a practical suggestion of means for recovering them, with exact data of the building space to be heated per horse power of engine. 2700 w. The Engineering Magazine—July, 1900. No. 34760 B.

Oil Engines.

Two-Stroke Oil Engines. The advantages and the practical difficulties are considered briefly. 1500 w. Auto Jour—June, 1900. No. 35059 A.

STEAM ENGINEERING.

Accidents.

Accidents to Steam Engines. W. H. Wakeman. Illustrated account of accidents and the methods of repairing them. 1200 w. Power—June, 1900. No. 34523.

Boiler Explosion.

Disastrous Boiler Explosion on the Austrian Torpedo Boat "Adler." J. Heinz. An illustrated account of a disaster that occurred while the vessel was steaming in the Adriatic Sea, on July 22, 1899. 1200 w. Marine Engng—June, 1900. No. 34638 C.

Boilers.

Preparing Boilers for Periods of Idleness. Suggestions and detailed description of operations necessary to leave a boiler in proper condition for starting when needed. 2500 w. Engr, U. S. A.—June 15, 1900. No. 34897.

Chimneys.

The Height and Area Required for Chimney Draft. H. G. Brinckerhoff. Read at meeting of the N. E. Cotton Mfrs.' Assn. Suggestions for the designing of chimneys for meeting stated conditions. 2500 w. Power—June, 1900. No. 34522.

Compression.

The Influence of Compression in Cylinder Clearance Spaces Upon Steam Consumption per I. H. P. Extracts from notes by B. F. Isherwood and Prof. Develshauvers-Dery. 2000 w. Jour Am Soc of Nav Engs—May, 1900. No. 34648 H.

Condensation.

Cylinder Condensation. An explanation of jacket action and the effects of condensation. 1600 w. Elec Rec, Lond—June 8, 1900. No. 34900 A.

Engine Tests.

Tests of a 3000 Horse-Power Engine in the Luisenstrasse Central Station, Berlin (Stehende Dampfdynamomaschinen von 3000 PS in der Zentrale "Luisenstrasse" der Berliner Elektrizitätswerke). A short account, with tables, of tests made of a vertical triple expansion engine. 400 w. Zeitschr d Ver Deutscher Ing—May 12, 1900. No. 34711 D.

Fuels.

The Performance of Boilers, Judged from a Chemical Standpoint (Zur Beurteilung der Leistung von Dampfkesseln vom Chemischen Standpunkt aus). H. Bunte. A very thorough review of the chemical composition and calorific power of fuels, and the composition and temperature of chimney gases, with full tables. 5000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34717 D.

Governors.

A New Measure of Good Quality in Governors. R. H. Smith. An explanation of measures of governor good quality based on geometric sensitiveness, force-power, energy-power and stability. 2800 w. Engr, Lond—May 25, 1900. No. 34603 A.

Liquid Fuel.

Liquid Fuel Apparatus of S. S. "Cardium." Illustrated description of apparatus and plan. 800 w. Engr, Lond—May 25, 1900. No. 34606 A.

Multiple Expansion.

Receiver Drop in Multiple Expansion Engines. R. L. Weighton. Explains results obtained from recent trials on experimental engines at the College of Science, Newcastle-upon-Tyne, made to determine the most economical point of steam cut-off Also discussion. 8500 w. Trans N. E. Coast Inst of Engs & Shipbuilders—April, 1900. No. 34643 F.

Packing.

Piston Rod and Valve Stem Packing. C. B. Conger. Describes the two general types of metallic rod packing in use, and the care it needs. 1500 w. Loc Engng—July, 1900. No. 35083 C.

Paris Exposition.

Power Features of the Paris Exposition. W. H. Donner. A well-illustrated description of boiler and engine plants characteristic of continental practice, with text explanations of the striking features of the several installations. 3000 w. The Engineering Magazine—July, 1900. No. 34761 B.

Prime Movers at the Paris Exposition. A review of the various exhibits. 4000 w. Engr, Lond—June 8, 1900. Serial. 1st part. No. 34908 A.

The Engines of the Paris Exposition. Illustrates and describes steam engineering exhibits of interest. 4500 w. Power—July, 1900. No. 35077.

Steam Engines.

The Story of the Steam Engine. Its history and development are reviewed. 2500 w. Loc Engng—June, 1900. Serial. 1st part. No. 34594 C.

Traction Power Plant.

See Electrical Engineering, Generating Stations.

Triple Expansion.

High Speed Vertical Triple Expansion Engine of 1500 Horse Power (Schnellgehende Stehende Dreifach-Expansionsmaschine von 1500 PS). Leopold Kliment. A well illustrated description of engines for driving pairs of dynamos in a Vienna central station. 1000 w. 3 plates. Zeitschr d Ver Deutscher Ing—June 2, 1900. No. 34719 D.

MISCELLANY.

Balloons.

The Dragon Balloon. A. Von Parseval. Illustrates and describes the characteristics and principles of action. 2300 w. Jour of U. S. Art—May-June, 1900. Serial. 1st part. No. 34552 D.

Carborundum.

Manufacture of Carborundum at Niagara Falls. Illustrated description of the method. 2200 w. Sci Am—June 16, 1900. No. 34831.

Laboratory.

The Engineering Laboratory of the Berlin Technical High School. Information concerning this establishment and the work done in it. 3000 w. Engng—June 8, 1900. No. 34901 A.

Ordnance.

Vickers' Ordnance at the Paris Exposition. Illustrated description of the fine exhibit of modern ordnance. 2500 w. Engng—June 8, 1900. No. 34902 A.

Roller Bearings for Artillery. E. W. Hubbard. Illustrates and describes a bearing believed to be especially adapted to this service and capable of greatly reducing artillery draft. 700 w. Jour of U. S. Art—May-June, 1900. No. 34550 D.

The Dismountable Gun of the State of Congo. Illustrates and describes a gun made dismountable, that it may be easily carried by men or animals. 800 w. Sci Am Sup—June 9, 1900. No. 34680.

Paris Exposition.

Paris Exposition of 1900. Albert Shaw. A general review of the Exposition, with illustrations, making some comparisons with the Chicago Exposition, and others held in Paris. 5000 w. Rev of Revs—June, 1900. No. 34548 C.

The Paris Exposition of 1900. Andrew D. Fuller. Illustrated description of some of its general features. 2000 w. Mach, N. Y.—June, 1900. No. 34559.

Postage Distributer.

Postage Stamp and Postal Card Distributer. Illustrates and describes an apparatus invented by M. de Janisch, which has overcome the many difficulties and provided for the automatic supply of stamps and postal cards. 1700 w. Sci Am Sup—June 30, 1900. No. 35069.

Wood Screws.

See Architecture, Construction.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Alabama Coalfield. On the importance of this field and the effect it is destined to have upon the foreign as well as the domestic supply. 3500 w. Engng—June 8, 1900. No. 34905 A.

Belgium.

Neuville Pit of the Grand-Mambourg-Sablonniere Colliery, Belgium. Notes of a visit, describing the Reumaux safety applinace for the prevention of over-winding, and other interesting equipments. Ill. 1600 w. Col Guard—June 1, 1900. No. 34814 A.

Coking.

By-Product Coking in Western Pennsylvania. William Gilbert Irwin. Considers the advantages of the by-product ovens over the best hive oven, and the economic superiority of the system. Ill. 1200 w. Eng & Min Jour—June 16, 1900. No. 34878.

Costs.

Colliery Costs. Present and Prospective. A discussion of English mining costs. 3200 w. Col Guard—June 1, 1900. No. 34816 A.

The Cost of Coal. Norton H. Humphrys. Discusses how the increased price of coal has affected gas-works, and means of covering the increase in expenditure without raising the price of gas. 3000 w. Jour Gas Lgt—June 12, 1900. No. 34939 A.

Electrical Machinery.

See Electrical Engineering, Power Applications.

Gob Workings.

Drawing Gas from Gob Workings by Bore Holes. Charles Connor. Read before the Western Penna. Cent. Min. Inst. Explains certain conditions under which this method is most effective and cheapest. 1600 w. Mines & Min—June, 1900. No. 34624 C.

Ireland.

The Coalfields of Ireland. An outline of the general character of these coalfields, and of the conditions under which they occur. Ill. 2600 w. Col Guard—June 15, 1900. Serial. 1st part. No. 34991 A.

Kansas.

Correlative Relations of Certain Subdivisions of the Coal Measures of Kansas. Charles R. Keyes. Calls attention to similarity of results obtained 40 years ago and conclusions arrived at by recent workers. 2300 w. Am Geol—June, 1900. No. 34652 D.

Michigan.

The Coal Basin of Michigan. A. C. Lane. Gives a sketch map showing the approximate extent of the coal basin, information concerning its deposits, characteristics and development. 1800 w. Eng & Min Jour—June 30, 1900. Serial. 1st part. No. 35079.

Mine Statistics.

Suggestions for Improved Coal Mining Accident Statistics. F. L. Hoffman. Also editorial. A discussion of needed improvements in methods of compiling, with suggestions of value. 3500 w. Eng & Min Jour—June 2, 1900. Serial. 1st part. No. 34571.

New Zealand.

Notes on the Coalfields of New Zealand. James Park. Read before the Inst. of Min. and Met., London. Concerning the quality and quantity of coal available. 2200 w. N. Z. Mines Rec—April 16, 1900. No. 34691 B.

Power Plant.

Utilizing a Feeder for Driving a Winch. Illustrates and describes an installation of a turbine-driven winch. 1000 w. Col Guard—June 1, 1900. No. 34815 A.

Production.

The Coal Production of the Principal Countries of the World. Statement showing what has been the production in the five principal coal producing countries in the years 1897, 1898 and 1899. 2200 w. Col Guard—May 25, 1900. No. 34601 A.

United States Coal Production in 1899. Completed tables of production showing that for the first time Great Britain has taken second place and the United States leads. 1000 w. Eng & Min Jour—June 2, 1900. No. 34569.

Queensland.

Coal Mining in Queensland. The great extent of the deposits, present output, legislation, etc. 1400 w. Col Guard—June 8, 1900. No. 34906 A.

Co-operative Coal Mining in Queensland. Harrison F. Bulman. Explains the manner of conducting the Aberdare Colliery at Blackstone. Also describes method of working. 1500 w. Col Guard—June 15, 1900. No. 34992 A.

Roentgen Tests.

Examination of coal by Röntgen Rays. Investigations of F. Kotte as published in *Stahl und Eisen*. Ill. 400 w. Sci Am—June 23, 1900. No. 34956.

COPPER.

Lake Superior.

Lake Superior Mining Region. William Kelly. The present condition of the mining industry as compared with former years. The introduction of new machinery and methods by which the output has been increased and the cost of production lessened. 3800 w. Mines & Min—June, 1900. No. 34625 C.

Mexico.

The Nacosari Mines, Mexico. H. B. Layton. An illustrated account of the development of a large copper mine. 1600 w. Eng & Min Jour—June 9, 1900. Serial. 1st part. No. 34666.

Smelting.

The Pyritic Smelting of Copper Ores. C. C. Lougridge. Explains the object of pyritic smelting, the constituents of the ores, the thermal relation and estimation of the carbonaceous fuel required, action of the furnaces, etc. 3000 w. Engng—June 15, 1900. No. 34986 A.

GOLD AND SILVER.

Assaying.

The Assaying of Gold and Silver Ores. William B. Gamble. Describes all the preparatory operations, the system of assay weights, the assay, and the care needed in the operations. 2200 w. Sci Am—June 2, 1900. No. 34505.

Australia.

Tarcoola Gold Field. Concerning a recently discovered gold field in South Australia. Maps. 900 w. Aust Mine Stand —April 26, 1900. No. 34632 B.

Black Hills.

The Bear Butte Mineral Formation. Robert W. Barrell. An illustrated description of the interesting Black Hills mining region and an account of its peculiarities. 3400 w. Mines & Min—June, 1900. No. 34628 C.

California.

Mining on the California Gold Belt. W. H. Storms. An account of recent workings by improved methods. 1500 w. Min & Sci Pr—May 26, 1900. Serial. 1st part. No. 34512.

Cape Nome.

The Auriferous Sands of Cape Nome (Les Sables Aurifères du Cap Nome, Alaska). R. de Batz. A general description of the Cape Nome region and gold fields, with maps. 3500 w. Génie Civil—June 9, 1900. No. 34755 D.

Colorado.

The Geology and Vein Systems of the Mount Wilson Mining District, Colorado. Frank L. Nason. Illustrated description of this region and the character of the ore deposits. 2200 w. Eng & Min Jour—June 9, 1900. No. 34668.

Cyanide.

Precipitation of Gold from Cyanide Solutions. H. Watson. Discusses the methods at present in use, and the experiments tried by the writer. 1300 w. Mod Mach —June, 1900. No. 34554.

Deposits.

The Golden Mountain. William Bradford. An account of a great mining boom in the early '90's. Ill. 1700 w. Aust Min Stand—April 26, 1900. Serial. 1st part. No. 34633 B.

Dredging.

Dredging for Gold. J. W. H. Piper. On the advantage of the bucket-dredge as a gold producer. 2100 w. Aust Min Stand—May 10, 1900. No. 34924 B.

Dumps.

Working Over an Old Dump. Describes an old dump in California being worked with profit, though first worked closely and economically. Describes the process employed by the old company and the present method. Ill. 2800 w. Min & Sci Pr—May 26, 1900. No. 34511.

Lixiviating.

Lixiviating or Leaching Processes. J. Ohly. Remarks on various processes. 3500 w. Ores & Met—June, 1900. No. 34841.

New South Wales.

Temora Gold Field (N. S. W.). W. Green. Information concerning the geology of these deposits. 1200 w. Aust Min Stand—April 26, 1900. No. 34634 B.

Placers.

Gold Placers in Glaciated Regions. George H. Stone. Why they present different conditions from those which have not been affected by glaciation. Ill. 2700 w. Mines & Min—June, 1900. No. 34626 C.

Production.

Gold and Silver Production in 1899. Completed tables of production for the year for the United States, and for the world. 2500 w. Eng & Min Jour—June 2, 1900. No. 34568.

Russia.

Russian Laws on Gold Mining. Translation and condensation from a recent French publication giving information on this subject. 2200 w. U. S. Cons Repts, No. 754—June 13, 1900. No. 34821 D.

Smelting.

Notes on Lead Smelting and Gold and Silver Refining. Malvern W. Iles. Illustrates and describes apparatus for collecting solids from smoke and fumes. 1100 w. Eng & Min Jour—June 2, 1900. No. 34570.

Stamp Mill.

The Evolution of the 300-Stamp Mill on Douglas Island, Alaska. Henry Watson. Describes this new mill, giving an account of the crushing capacity and manner of operating. Ill. 2000 w. Min & Sci Pr—June 16, 1900. No. 34936.

IRON AND STEEL.

Blast-Furnace Gas.

See Mechanical Engineering, Special Motors.

Brown Ore.

Georgia's Brown Ore Fields. Interesting detailed description of the extensive deposits and their commercial character. 1400 w. Am Mfr & Ir Wld—June 7, 1900. No. 34696.

Competition.

American Engineering Competition. Lowthian Bell. From the London *Times*. A letter in defence of the British iron and steel trades. 2600 w. Ir & Coal Trds Rev—June 15, 1900. No. 35002 A.

Cupola Practice.

Concerning Cupola Practice in Bessemer Steel Works. S. M. Rodgers. Read and discussed before the Pittsburg Found. Assn. Considers the circumstances and conditions governing the manipulation of the cupola in the Bessemer steel works. 3000 w. Ir Trd Rev—June 21, 1900. No. 34926.

Germany.

The Iron Industries of Germany. Interesting statistics concerning production, imports and exports and related information. 3000 w. Ir Age—May 31, 1900. No. 34510.

Iron Trade.

The Iron Situation from a British Point of View. J. Stephen Jeans. Summarizes recent events, the trend of prices, supply and consumption all over the world, and the effect of prevailing high prices in checking constructive enterprise. 2700 w. The Engineering Magazine—July, 1900. No. 34764 B.

What Is the Competitive Outlook in the World's Iron and Steel Trades? or, more particularly, What is the Outlook for the British Iron Trade? H. J. Skelton. Read before the British Iron Trade Assn. Discussion of subject. 7200 w. Ir & Coal Trds Rev—June 15, 1900. No. 35001 A.

Minette District.

The Minette District of Lorraine, Luxembourg and France. Illustrated account of the iron deposits, production, mining cost, etc. Map. 4700 w. Ir Age—June 28, 1900. Serial. 1st part. No. 35057.

Pennsylvania.

Iron in Western Pennsylvania. From *The News,* Scottdale, Pa. Gives history of early blast furnaces and account of ores found and their uses. 2000 w. Am Mfr & Ir Wld—June 21, 1900. No. 34977.

Stassano Process.

The Stassano Process for the Production of Iron and Steel. John B. C. Kershaw. Considers this process, being tried in Italy, and discusses the economy of the electric current when used for heating. 1700 w. Elec Rev—June 15, 1900. No. 35011 A.

MINING.

Accidents.

Scofield Mine Disaster. Don Maguire. Describes the disaster in the mines of the Pleasant Valley Coal Co., Scofield, Utah. 1800 w. Mines & Min—June, 1900. No. 34622 C.

The Red Ash Mine Explosion in West Virginia. Report of J. W. Paul on the explosion that occurred last March, killing 46 men. 2000 w. Eng & Min Jour—June 9, 1900. No. 34667.

Air-Doors.

Interlocking Mine Air-Doors. M. Martinet. Illustrated description of a method without any rigid part for transmitting motion. 600 w. Col Guard—May 25, 1900. No. 34600 A.

Concrete.

The Use of Concrete in Mining. Marcel Habets. From a communication to the Liége section of the Societé des Ingenieurs de Liége. Its use for shaft-lining. underground engine-room, stoppings, lining a fan drift, etc., and the advantages are presented. Ill. 2500 w. Col Guard—June 15, 1900. No. 34993 A.

Gallery.

The Construction of a Subterranean Gallery Which Is to Connect the Lignite Mines of Gardanne, near Marseilles, with the Sea (Mines de Lignite de Gardanne (Bouches-du-Rhone) Construction d'une Galerie Souterraine Destinée à Relier la Concession à la Mer). H. Schmerber. A long and well illustrated account of methods of construction and apparatus employed. Serial. 3 parts. 6000 w. Génie Civil—May 26, June 2, 9, 1900. No. 34752 each D.

Hoisting Machinery.

Hoisting with a Driving Wheel (Die Förederung mit Treibscheibe). A. Ehrlich. A well illustrated description of the machinery used in hoisting the cages in shafts by an endless rope driven by a large wheel. 3000 w. Zeitschr d Ver Deutscher Ing—May 26, 1900. No. 34718 D.

Shaft Sinking.

Sinking Parker Shaft at Zinc Mines, Franklin Furnace, New Jersey. J. A. Van Mater. An account of the means used to control the inflow of water in the shaft, plans of timbering, placing holes for blasting, and method of firing by electric dynamo. Ill. 5000 w. Mines & Min—June, 1900. No. 34621 C.

Timbering.

On the Theory of Timbering. Henry Louis, in the *Colliery Manager.* The need of data at present unknown, which can only be derived from experiment. 2800 w. Mines & Min—June, 1900. No. 34627 C.

Wire Rope.

Wire Rope—Its Uses, Abuses and Care. Justin S. Doe. Read before the Ohio Inst. of Min. Engs. The origin, construction, and need of proper care to preserve it. 2000 w. Mines & Min—June, 1900. No. 34629 C.

MISCELLANY.

Aluminum.

Aluminum in India. Report on the condition of the industry, by Alfred Chatterton. 1300 w. Jour Soc of Arts—May 25, 1900. No. 34612 A.

Recent Progress in the Aluminum Industry. Joseph W. Richards. Remarks on recent advances and improvements in methods. 2800 w. Jour Fr Inst—June, 1900. No. 34645 D.

British Columbia.

History of Progress of Mining in British Columbia. H. Mortimer Lamb. A comprehensive review of the development of the region, including discoveries, exploitation, mining methods and equipment, and economic conditions, with many fine illustrations. 5400 w. The Engineering Magazine—July, 1900. No. 34762 B.

China.

The Value of Chinese Mining Concessions. John A. Church. A discouraging report of the mining outlook in China. 1100 w. Eng & Min Jour—June 23, 1900. No. 34984.

Clay.

The Clay-Working Industry of the Pacific Coast. Heinrich Ries. Facts in regard to the clay deposits and the extent of their utilization. 1500 w. Mines & Min—June, 1900. No. 34623 C.

Granite.

Granite and Granite Quarrying. F. T. Mallon. Concerning the selection of a site and related matters affecting success. 3300 w. Stone—June, 1900. No. 34872 C.

The Granites of Sweden. From *The Stonemason*. Information concerning the granite of Norway and Sweden. 800 w. Stone—June, 1900. No. 34873 C.

Nickel.

Nickel Mining in New Caledonia. Brief illustrated account of the deposits and ores in this South Sea island. 600 w. Eng & Min Jour—June 23, 1900. No. 34983.

Ore Deposits.

Horses and Breccia. An explanation of these terms, as applied to mining, and of their causes. 1000 w. Min & Sci Pr—June 2, 1900. No. 34674.

Production.

The Mineral Statistics of the United Kingdom for 1899. Extracts from the Home Office. Returns concerning persons employed, output and accidents. 1300 w. Ir & Coal Trds Rev—June 1, 1900. No. 34807 A.

United States Mineral and Metal Production. Tables showing the total production for 1899, comparing with the previous year. Also comments. 6200 w. Eng & Min Jour—June 9, 1900. No. 34665.

Siberia.

Siberian Mining Concession. Concerning concessions and the mining industry, the restrictions and the outlook. Does not advise Americans without capital to enter this field. 1600 w. U. S. Cons Repts, No. 754—June 13, 1900. No. 34820 D.

Smelting.

Smelting Process for Zinc Ores. Concerning the process invented by Emil E. Lungwitz for the smelting of refractory ores. 1500 w. Sci Am—June 9, 1900. No. 34675.

Sulphur.

The Production of Sulphur in England. An editorial explaining why the Anglo-Sicilian Sulphur Co. was formed, the process of recovery used, the product, etc. 2700 w. Engng—June 15, 1900. No. 34988 A.

Veins.

Enrichment of Mineral Veins by Later Metallic Sulphides. Walter Harvey Weed. From the *Bulletin of the Geol. Soc. of Am.* An explanation of chemical and mineralogic changes in deposits. 1200 w. Min Rept—June 21, 1900. Serial. 1st part. No. 34982.

Zinc.

Notes on the Ferrocyanide Titration of Zinc. Edmund H. Miller and E. J. Hall. Experiments made to find out the influence of hydrochloric acid and those salts most likely to be present on the estimation of zinc by titration with potassium ferrocyanide, using uranium acetate as an indicator. 1600 w. Sch of Mines Quar—April, 1900. No. 34896 D.

The Joplin Zinc District of Southwest Missouri. James H. Steele. An illustrated account of this district, which produces over one-third of the world's supply of zinc. 3400 w. Min & Sci Pr—June 9, 1900. No. 34822.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in April. Detailed list and classified summary. 3300 w. R R Gaz—June 8, 1900. No. 34641.

Fast Trains.

The Cost of Running Fast Trains. G. R. Hudson. Treats of results obtained on the test plant of the Chicago & North-Western Ry., in regard to fuel consumption. 800 w. Am Engr & R R Jour—June, 1900. No. 34581 C.

India.

Indian Railways. Comments on the influence of disasters that have visited the country, and information on the last report of the Railway Department. 1800 w. Engr, Lond—June 15, 1900. No. 34994 A.

Mineral Transport.

British Traders and British Railways, with Reference to the Control and Cost of Mineral Transport. John J. Jenkins. Read before the British Iron Trade Assn. Discusses the importance of the country acquiring the control of the railroads, and proposals for the purchase. Also general discussion. 7500 w. Ir & Coal Trds Rev—June 15, 1900. No. 35000 A.

MOTIVE POWER AND EQUIPMENT.

Adams' Train.

Adams' Air-Splitting Train. An illustrated description of the cigar-shaped train fitted up by Frederick U. Adams for reducing the resistance of the air. 700 w. R R Gaz—June 8, 1900. No. 34640.

Experimental Train for Testing Atmospheric resistance. Illustration of the train and an account of the trial run of forty miles between Baltimore and Washington. Also editorial. 1600 w. Sci Am —June 9, 1900. No. 34676.

Boilers.

Stationary Shop Boilers. F. W. Dean. A plea for the locomotive type of boiler in stationary service, claiming economy and commenting on statements made concerning them. 7500 w. R R Gaz—June 15, 1900. No. 34891.

Box Car.

Design for Standard Box Car. Committee report, with drawings. 400 w. Cent Ry Club—May, 1900. No. 34840 C.

Car-Axle Boxes.

Novelties in the Construction and Internal Arrangement of Wrought Iron Car-Axle Boxes for Railway and Tram Cars (Neuerungen in der Herstellung, Bauart und Inneren Einrichtung Schmiede-eiserner Achslager-Kasten für Eisenbahn-u. Strassenbahn-Fahrzeuge). F. Sürth. A paper before the Verein Deutscher-Maschinen-Ingenieure, giving a well illustrated description of recent German practice. 4500 w. Glaser's Annalen—June 1, 1900. No. 34746 D.

Cars.

American Railroad Cars at the Paris Exposition. Gives half-tone engravings of drawing showing the development of American cars, with description. 4000 w. R R Car Jour—June, 1900. No. 34823.

Combination Ballast and Gondola Cars, Wisconsin Central Ry. Illustrated description of a novel design. 700 w. Eng News—June 21, 1900. 34966.

Development of the Structural Steel Hopper Car. George I. King. Illustrated account of the development, giving interesting detailed information. 2000 w. Ry Age—June 22, 1900. No. 34978.

Double Deck Boarding Cars Built by and in Use on the St. Paul & Duluth R. R. Illustrated description. 600 w. Loc Engng—June, 1900. No. 34590 C.

Special Egyptian Railway Saloons. Illustrated detailed description of fine coaches. 900 w. Engr, Lond—June 15, 1900. No. 34996 A.

Coal Cars.

New 80,000 ℔. Coal Cars, Norfolk & Western Ry. Illustrated detailed description. 900 w. R R Gaz—June 15, 1900. No. 34888.

Convention.

Annual Convention of the Master Car Builders' Association at Saratoga, N. Y. Extracts from reports, with editorial. 8500 w. Eng News—June 28, 1900. No. 35076.

Couplings.

Automatic Couplings on Mineral Railways. A statement referring to the Taff Vale Ry., with discussion of whether automatic couplings would be superior to the present system. 2000 w. Engr, Lond —May 25, 1900. No. 34608 A.

Draft Gear.

Freight Car Draft Gears. Edward Grafstrom. Discussion of present devices in use and the fundamental principles of an approved draft rigging. 1800 w. Am Engr & R R Jour—June, 1900. No. 34580 C.

Dynamometer Car.

The Dynamometer Car in Tests for Railroads. L. P. Breckenridge. Paper and discussion. The construction and operation of the car is discussed. Ill. 10800 w. Cent Ry Club—May, 1900. No. 34838 C.

New Dynamometer Car. Illustrated description of the novel features of a car recently completed by the Chicago & Northwestern Ry. 900 w. Am Engr & R R Jour—June, 1900. No. 34576 C.

Exhaust.

The Need for Further Tests on Locomotive Exhaust Arrangements. H. H. Vaughan. Urges a continuation of experiments in order to settle the best exhaust arrangements for draft producing purposes. 1600 w. Am Engr & R R Jour—June, 1900. No. 34585 C.

Firebox.

The Wide Firebox as a Standard. J. Snowden Bell. Reasons why it should be standard for all types of engines. 2400 w. Am Engr & R R Jour—June, 1900. No. 34586 C.

Freight Cars.

Center Plates and Side Bearings for Freight Cars. Substance of two committee reports presented at convention of Master Car Builders' Assn. 4500 w. Eng News—June 21, 1900. No. 34965.

Repairs to Steel Freight Cars. C. A.

Seley. Outlines a shop and equipment suited to most roads and required by the use of steel in car construction. 2100 w. Am Engr & R R Jour—June, 1900. No. 34583 C.

"Front End."

Turner's New Short "Front End." Presents its advantages. Ill. 800 w. Am Engr & R R Jour—June, 1900. No. 34587 C.

Fuel.

Coke for Locomotive Fuel. George L. Fowler. Reviews European practice and the results accomplished, and gives details of its use in America. Ill. 3500 w. R R Gaz—June 22, 1900. No. 34972.

Locomotive Building.

Welding Locomotive Frames in Place with Oil. D. P. Kellogg. Illustrated description of a system in use at the Southern Pacific shops. 1500 w. Loc Engng—June, 1900. No. 34591 C.

Locomotive Design.

A Decade of Car and Locomotive Construction. George L. Fowler. A review of American rolling stock during the past ten years, showing the improvements and changes. 2800 w. Ry Age—June 15, 1900. No. 34869.

An Outline of the Development of the American Locomotive. Half-tone reproduction of drawings on exhibition at the Paris Exposition, with descriptive remarks. 2400 w. Sci Am Sup—June 9, 1900. Serial. 1st part. No. 34678.

A Suggestion for Improvement in Locomotive Design. R. A. Smart. Concerning the use of a lighter valve and yoke. 900 w. Ry Age—June 15, 1900. No. 34870.

Consideration of Weight of Parts in Locomotive Design. W. H. Marshall. Outlines where savings can be effected and to what extent they may be carried. 1800 w. Am Eng & R R Jour—June, 1900. No. 34577 C.

Exhaust and Draft in Locomotives. Portions of the report of Edouard Sauvage, with editorial. Ill. 5500 w. R R Gaz—June 29, 1900. No. 35074.

Locomotive Development from 1890 to 1900. F. W. Dean. Reviews improvements made, increase in size, materials used, increase in speed, etc. 3800 w. Ry Age—June 15, 1900. No. 34867.

Locomotive Progress in Ten Years. R. H. Soule. Considers improvements made in design and construction that increase the power and reduce expenses. 1300 w. Ry Age—June 15, 1900. No. 34868.

Locomotives in 1900. M. N. Forney. Comments on problem arising from increase in size and weight. 2000 w. Am Engr & R R Jour—June, 1900. No. 34578 C.

What Is the Ideal Fast Passenger Engine? S. M. Prince, Jr. Illustrations and descriptive specifications of the Phila. & Reading passenger locomotive No. 218. Also criticism of Columbia and Atlantic types. 1500 w. R R Gaz—June 22, 1900. No. 34969.

Locomotive Performance.

Comparative Performance of Heavy and Medium Weight Locomotives. F. F. Gaines. An account of the performance of engines in mountain pushing service on the Lehigh Valley R. R. 700 w. Am Engr & R R Jour—June, 1900. No. 34584 C.

Locomotives.

An Old English Locomotive. W. B. Paley. Illustrated description of one of the first class of express passenger locomotives which the Great Northern Co. of England had when the line opened in 1852. 700 w. R R Gaz—June 8, 1900. No. 34642.

Atlantic Type Fast Passenger Locomotive. Dimensions, illustration and interesting details of engine on the Pennsylvania R. R., of Class E1, Atlantic Type. 4700 w. Am Engr & R R Jour—June, 1900. No. 34575 C.

Brooks Convertible Type Locomotives for Egyptian State Rys. Illustrated descriptions of an engine that can be converted from an Atlantic type having driving wheels 78 in. in diameter into a 10-wheeler having driving wheels either 69 or 60 in. in diameter. 1000 w. Ry & Engng Rev—June 16, 1900. No. 34866.

Compound Consolidation Locomotives for the Baltimore & Ohio. Illustrations and description of engines, interesting because of the large number built from a single design. 600 w. R R Gaz—June 15, 1900. No. 34887.

Compound Decapod—Minneapolis, St. Paul & Sault Ste. Marie Ry. Illustrated description. 800 w. R R Gaz—June 22, 1900. No. 34975.

Compound Duplex Locomotive for the McCloud River R. R. Engine for a California road with grades of 2 per cent. to 4 per cent. and curves of 15°. 350 w. Eng News—June 28, 1900. No. 35075.

Duplex Compound Locomotive for Seven Per Cent. Grades. Brief illustrated description. 250 w. Am Engr & R R Jour—June, 1900. No. 34588 C.

German Locomotive Exhibit at Paris. (Die Weltausstellung in Paris 1900. Die Deutsche Kollektioausstellung von Locomotiven). A well illustrated general description of the exhibit, with details of some of the locomotives. Serial. 1st part. 5500 w. 4 plates. Glaser's Annalen—May 15, 1900. No. 34743 D.

Great Consolidation Locomotives for the Pittsburg, Bessemer & Lake Erie

Railroad. Illustration and general description of the largest and heaviest locomotive yet built. 1100 w. R R Gaz—June 29, 1900. No. 35073.

Locomotive Engines at the Paris Exposition. Describes some of the noteworthy features of the exhibit. 3800 w. Engr, Lond—June 8, 1900. No. 34910 A.

Midland Locomotive at the Paris Exposition. Two-page engraving and views, with principal dimensions and particulars. 700 w. Engng—June 1, 1900. No. 34809 A.

Some Holland Locomotives. Brief illustrated description. 300 w. Loc Engng—June, 1900. No. 34596 C.

Ten-Wheel Locomotives for Sweden. General dimensions and illustrated description of engines for the Ystad Eslof Ry. 350 w. Am Engr & R R Jour—June, 1900. No. 34589 C.

Odd Styles of Locomotives. D. P. Kellogg. Illustrated description. 400 w. Loc Engng—June, 1900. No. 34595 C.

The Heaviest Locomotive in the World, Pittsburg, Bessemer & Lake Erie R. R. Principal dimensions, with illustration. 500 w. Eng News—June 21, 1900. No. 34964.

The New York, Ontario & Western Consolidation Engines. A study of the hauling capacity of these engines as compared with certain others, and a table giving particulars of recent consolidation engines. 800 w. R R Gaz—June 15, 1900. No. 34895.

Lubrication.

Lubrication and Hot Boxes. H. B. Hodges. A discussion of car journal lubrication and the prevention of hot boxes. 4500 w. R R Gaz—June 15, 1900. No. 34893.

Mixed Brakes.

Tests of Westinghouse and New York Triple Valves. A report of an important series of tests of air brake apparatus, with editorial discussion. 9500 w. R R Gaz—June 15, 1900. No. 34886.

Oil Fuel.

Locomotives Using Oil for Fuel. Treats of the apparatus used and the mechanical side, from the view of a coal burner engineer. 2200 w. Loc Engng—June, 1900. No. 34592 C.

Rating.

Locomotive Rating on the Mexican Central. Describes the system in use for keeping a record of the tractive power. 1300 w. R R Gaz—June 15, 1900. No. 34890.

Reports.

The Reports of the Master Mechanics' Association. Extracts from most of the reports, and from the president's address, and discussions. Also editorial. 31700 w. R R Gaz—June 29, 1900. No. 35072.

Shops.

Some Elements of Modern Shop Arrangements. Suggestions relating to systems of arrangement found convenient and necessary for modern work. 1500 w. R R Gaz—June 15, 1900. No. 34889.

The Shifting Arrangements at the Gleiwitz Railroad Shops (Das Verschubgeschäft in der Hauptwerkstatt Gleiwitz). H. Lach. An illustrated description of arrangements for shifting cars about the repair shops, in which electricity is employed to a great extent. 2500 w. 1 plate. Glaser's Annalen—May 15, 1900. No. 34745 D.

The Arrangement of Boiler Shops. F. M. Whyte. A discussion of the general arrangement of a boiler shop forming a part of a locomotive repair plant. 2200 w. Am Engr & R R Jour—June, 1900. No. 34582 C.

Passenger Car Repair Shops. Illustrated description of the shops of the Lake Shore and Michigan Southern Ry. at Buffalo, N. Y. 2000 w. R R Car Jour—June, 1900. No. 34824.

Speed.

The Economy of Speed. F. P. Roesch. Discusses methods of rating engines and their maintenance. 1600 w. Loc Engng—July, 1900. No. 35084 C.

Staybolts.

Best Method of Applying Staybolts. Opinions of Mr. Archie Baird, foreman boilermaker at the Topeka shops, with illustrations of experimental tests. 1200 w. Ry & Engng Rev—June 16, 1900. No. 34865.

Tenders.

Locomotive Tenders. William Forsyth. Illustrated description of recent improvements in design. 1400 w. Am Engr & R R Jour—June, 1900. Serial. 1st part. No. 34579 C.

Trucks.

Passenger and Freight Car Trucks; Their Principles and Design. General discussion with illustrations. 17600 w. N. Y. R R Club—April 19, 1900. No. 34693.

Water.

Pure Water for Locomotives by Evaporation. Editorial discussing the advantages and the possibility of using distilled water for locomotives. 2400 w. R R Gaz—June 22, 1900. No. 34973.

Water Brake.

Test of Water Brake. Frank F. Coggin. An account of a series of tests made to ascertain the retarding power of the water brake, made on the mountain division of the Maine Central R. R. 1000 w. Loc Engng—June, 1900. No. 34593 C.

NEW PROJECTS.

China.

Imperial Chinese Railways. A detailed history of the railway projects in China. 2300 w. Engng—June 1, 1900. No. 34810 A.

The Present Status of Railway Development in China. Abstract of article by M. G. Bouillard in *Revue Generale des Chemins de Fer.* Facts of interest concerning the constructed and projected railways. Map. 1800 w. Eng News—July 5, 1900. No. 35183.

"Gradient" Railway.

The Halford Gradient Railway. Brief illustrated description of a peculiar English railway, the invention of Mr. Halford. 500 w. Eng News—July 5, 1900. No. 35,181.

North Michigan.

The Copper Range R. R. in the North Michigan Peninsula. Illustrated account of a new railway opening a section of the Michigan copper regions which has not hitherto been worked, owing to lack of transportation facilities. 2700 w. Eng News—May 31, 1900. No. 34514.

Paris.

General Description of the Railway Line from Courcelles to the Champ de Mars which Crosses the Seine by Viaduct (Ligne de Courcelles au Champ-de-Mars, à Paris). A. Dumas. A general description of this new connecting line, partly in tunnel and partly on viaduct, very well illustrated. 5000 w. 1 plate. Génie Civil —June 2, 1900. No. 34753 D.

Railway Scheme.

The Cosmopolitan Railway. Harry C. Martin. Brief discussion of the scheme proposed by ex-Gov. Gilpin of Colorado, for uniting five continents by one system of railroad. 1200 w. Yale Sci M—June, 1900. No. 34620 C.

Scottish Railway.

The Invergarry and Fort Augustus Railway. Description and sketch map of an important new line in Scotland. 1500 w. Transport—June 8, 1900. No. 34-875 A.

PERMANENT WAY AND FIXTURES.

Masonry.

Railroad Concrete Masonry. W. A. Rogers. Describes the qualities of concrete and the practice followed in its use by the writer. 3000 w. R R Gaz—June 15, 1900. Serial. 1st part. No. 34894.

Rails.

Rails and Rail Joints. Illustrated description of the types now in use. 1800 w. Sci Am Sup—June 9, 1900. No. 34681.

Round Houses.

Construction, Equipment and Ventilation of Round Houses. Committee report with illustrations. 2500 w. Cent Ry Club—May, 1900. No. 34839 C.

Shops.

See also Motive Power and Equipment, above.

New Shops and Yards of the Colorado & Southern Ry. Plans, sections and description of large shops being built in Denver, Colo. 2000 w. R R Gaz—June 15, 1900. No. 34892.

Signaling.

A System of Signaling for Railways. W. S. Boult. Abstract of a paper read before the Brit. Assn. for the Adv. of Science. Illustrates and describes an apparatus for fog signaling. 5500 w. Eng News—June 14, 1900. No. 34883.

Signals.

Tests of Railroad Signal Glass. Louis Derr. Extracts from a paper read before the New England R. R. Club. Gives the results of a series of rather severe tests. 1800 w. Ry & Engng Rev—June 30, 1900. No. 35131.

Switches.

Westinghouse Electro-Pneumatic Switch and Signal System at the Bishopsgate Station of the Great Eastern Railway (Elektrisch Gesteuertes Druckluft-Stellwerk, Bauart Westinghouse, Ausgeführt von der Great Eastern Eisenbahn). A well illustrated description of the plant, with some switch and signal details. 2200 w. Glaser's Annalen—June 1, 1900. No. 34748 D.

Track.

Pot Sleepers on the Great Indian Peninsula Ry. Illustrates the pattern now standard with this company and gives a brief account of past experience with these sleepers. 700 w. Ry & Engng Rev—June 9, 1900. No. 34698.

Track Improvements on German Railways. Information from an address by Prof. Goering. 1600 w. Ry & Engng Rev—June 9, 1900. No. 34699.

Tracklaying by Machinery on the Canadian Pacific Ry. Description of the work and the machine. 1700 w. Eng News—June 14, 1900. No. 34882.

TRAFFIC.

Brazil.

Railways in Brazil. Information collected from various sources concerning the history, operation, rates, regulations, etc., of the lines. 13800 w. U. S. Cons Repts, No. 758—June 18, 1900. No. 34871 D.

Statistics.

The Railroads of the World. Condensed table from the *Archiv für Eisenbahnwesen.* 400 w. R R Gaz—June 1, 1900. No. 34572.

STREET AND ELECTRIC TRAMWAYS

Berlin.

Electric Traction on the Berlin Metropolitan Railway. Translated from the *Elektrotechnische Zeitschrift.* Illustrates and describes the scheme proposed by the Union Elektricitäts Gesellschaft. 6700 w. Tram & Ry Wld—June 7, 1900. No. 35071 A.

The Introduction of Electric Power on the Great Berlin Street Railway up to the End of 1899 (Die Einführung des Elektrischen Betriebes auf der Grossen Berliner Strassenbahnen und Stand desselben Ende 1899). A general descriptive article on the Berlin street railway overhead trolley system, well illustrated. 3600 w. Zeitschr f Klein u Strassenbahnen—May 1, 16, 1900. Serial. 2 parts. No. 34704 each C.

Birmingham, Ala.

The Street Railway of Birmingham, Ala. Illustrated detailed description. 2200 w. St Ry Jour—June 2, 1900. No. 34566 D.

Budapest.

The Budapest-Budafaker Suburban Electric Railway (Die Budapest-Budafaker Elektrische Localbahn). J. v. Fischer and Dr. A. Brunn. A general description, with details of the construction and equipment of this trolley road to an outlying suburb. 2800 w. Zeitschr f Klein-u Strassenbahnen—May 16, 1900. No. 34707 C.

Cars.

Passenger Cars for Boston Elevated Railway. A. Richards. Illustrated description. 1000 w. R R Car Jour—June, 1900. No. 34825.

Cuba.

The First Cuban Electric Railway. Brief illustrated description of the line from Regla to Guanabacoa. 700 w. Elec Wld & Engr—June 2, 1900. No. 34558.

Ekaterinoslav.

Electric Railway Plant at Ekaterinoslav, South Russia (Elektrische Bahnanlage in Jekaterinoslaw). Messrs. Winkler and Orban. An illustrated description of a trolley road, power house, and details. 3200 w. Elektrotech Zeitschr—May 24, 1900. No. 34732 B.

Electrical Equipment.

The Electrical Equipment of the Waterloo and City Railway. Bernard Maxwell Jenkin. Read before the British Inst. of Civ. Engs. Illustrated detailed description. 3500 w. Prac Engr—June 15, 1900. Serial. 1st part. No. 35003 A.

Electrolysis.

Electrolysis from Facts and Figures. E. E. Brownell. Discusses the conditions under which most electric roads are now operated, the defective construction, etc. Illustrations and discussion. 3500 w. Jour N. E. Water Wks Assn—June, 1900. No. 34500 E.

Electrolysis in Gas and Water Mains. D. Irving. Read at Bristol meeting of the So. Dist. Assn. of Gas Engs. and Mgrs. Explains the Bristol method for its prevention. 1800 w. Jour Gas Lgt—June 5, 1900. No. 34835 A.

Engine Economy.

Economy of Simple or Compound Engines for Traction Work. W. H. Booth. A discussion of the advantages and disadvantages of the two types. 2200 w. Elec Rev, Lond—June 15, 1900. No. 35010 A.

Heavy Track.

Heavy Track Construction in New Orleans. Illustrates and describes probably the heaviest T-rail track construction ever laid for electric service in the United States. 1000 w. St Ry Jour—June 2, 1900. No. 34567 D.

Interurban.

The Indianapolis, Greenwood and Franklin Interurban. Cloyd Marshall. Map, illustrations, and description. 2000 w. St Ry Rev—June 15, 1900. No. 34931 C.

The Lexington and Boston Electric Railway. An illustrated account of an electric road following for a large part of its course close to the route made famous by Paul Revere's ride. 3000 w. St Ry Jour—June 2, 1900. No. 34565 D.

Ithaca, N. Y.

Car Tests at Ithaca, N. Y. E. L. West. Describes tests made to determine the condition of the line and behavior of the cars when in regular service. 2500 w. St Ry Rev—June 15, 1900. No. 34930 C.

The Street Railway System of Ithaca, N. Y. H. S. Cooper. An account of the road, the route, etc. 2500 w. St Ry Rev—June 15, 1900. No. 34929 C.

Light Railways.

British and Colonial Light Railways. Editorial discussion of the working of the British Light Railway Act. 3300 w. Engng—May 25, 1900. No. 34599 A.

Mono-Rail.

The Mono-Rail Suspended Railway of Barmen-Elberfeld. Full illustrated description of this novel railway, and the immense increase in speed that will be possible. 2300 w. Tram & Ry Wld—May 10, 1900. No. 34503 A.

Moving Sidewalk.

The Moving Sidewalk at the Paris Exposition of 1900 (Die Rollende Trottoire der Weltausstellung von 1900). A general description, with two illustrations. 800 w. Zeitschr f Klein u Strassenbahnen—April 16, 1900. No. 34703 C.

The Moving Sidewalk at the Paris Exposition. Illustrated description, with comments on its success and method of operation. 3300 w. Elec Wld & Engr—June 30, 1900. No. 35125.

Nice.

Electric Tramways of Nice and of the Littoral. Illustrates and describes a transformed system, including the latest appliances for electric traction. 1500 w. Tram & Ry Wld—May 10, 1900. No. 34504 A.

Oberammergau.

The Murnau-Oberammergau Railroad. Illustrated description of a road made for the use of either steam or electricity. Also an account of the first performance of the passion play this season. 700 w. Sci Am Sup—June 2, 1900. No. 34508.

Power House.

See Electrical Engineering, Generating Stations.

Rapid Transit.

The New York Rapid Transit Road (Die Rapid Transit-Stadtbahn für New York). F. M. v. d. Werra. A good description, very well illustrated, of the road in general and various details of construction. Serial. 2 parts. 7500 w. Zeitschr d Ver Deutscher Ing—May 26, June 2, 1900. No. 34716 each D.

Rotary Currents.

Experiments with High Tension Rotary Currents for Electric Railways (Versuche über Verwendung des Hochgespannten Drehstromes für den Betrieb Elektrischen Bahnen). Walter Reichel. A full and well illustrated account of experiments made by the Siemens-Halske Co. with live voltages up to 10,000, transformed down to 750 on the electric locomotive. 6000 w. Elektrotech Zeitschr—June 7, 1900. No. 34737 B.

Safety Rules.

System of Safety Regulations for Electric Railway Plants (Entwurf zu Sicherheitsregeln für Elektrische Bahnanlagen). A preliminary plan of a committee of the Verband Deutscher Elektrotechniker, containing regulations for overhead trolley and accumulator roads, covering all parts of the plant. 1500 w. Elektrotech Zeitschr—May 10, 1900. No. 34723 B.

Service Problems.

Number of Cars Required on a Given Length of Track at Various Speeds and Headways. H. C. King. Diagram, graphically presenting all information pertaining to any required service. 400 w. Tram & Ry Wld—May 10, 1900. No. 34502 A.

Southampton.

Southampton Corporation Electric Tramways. Illustrated detailed description of the system. 2300 w. Tram & Ry Wld—May 10, 1900. No. 34501 A.

Southampton Corporation Tramways. Illustrates and describes interesting features of the line. 2500 w. Elec Engr, Lond—June 8, 1900. No. 34932 A.

Stray Currents.

Methods for Lessening the Danger of Stray Currents from Electric Tramways, Particularly the Kapp Method of Relieving the Rails of Current. (Ueber Methoden zur Verringerung der Gefahren Vagabundirender Ströme bei Elektrischen Bahnen, insbesondere die Kapp'sche Methode der Sahienenentlastung). Dr. J. Teichmüller. A description of the Kapp method of making the rails the neutral wire of a 3-wire system, with practical applications. 2000 w. Elektrotech Zeitschr—May 31, 1900. No. 34735 B.

Subways.

The Choice of an Operating System for City Subway Roads (Die Wahl des Betriebs-Systemes für Städtische Tiefbahnen). Gustav Schimpff and Wm. Kübler. A general review of the principal subway roads of the world, with table and illustrations. Serial. 1st part. 800 w. Deutsche Bauzeitung—May 5, 1900. No. 34701 B.

Sydney.

George and Harris Street (Sydney) Electric Tramway. Detailed description of the first electric line in Sydney. 2200 w. Engr, Lond—April 27, 1900. No. 34076 A.

Tramway Currents.

The Action of Electric Tramway Currents on Submarine Cables and Other Electric Circuits. Andrew Jamieson. An explanation of the causes of delay in the transmission of telegrams from Cape Town to England. Also discussion. Ill. 7500 w. Trans Inst of Engs & Shipbuilders in Scotland—Feb., March and April, 1900. 3 parts. No. 34326 each D.

Tri-phase.

The Tri-Phase Electric Cable Road on Mont Dore, France (Die mit Drei-phasen Strom Elektrisch Betriebene Seilbahn auf den Mont-Dore (Departement Puy-de-Dome) in Frankreich.) From an address by E. A. Ziffer before the Verein für die Förderung des Local-und Strassenbahwesens. A short description of this cable road, said to be the only one in Europe worked by tri-phase current. 400 w. Zeitschr für Klein-u Strassenbahnen—May 1, 1900. No. 34706 C.

Trolleys.

Some of the Principal Types of the Over-Head Trolley. Spencer Baird Prentiss. Brief illustrated description of types comparatively little known. 1200 w. Elec Rev, N. Y.—June 27, 1900. No. 35128.

Underground.

Electric Traction on the Metropolitan District Railway. An illustrated description of what has been thus far accomplished. Also editorial. 3500 w. Elect'n, Lond—May 25, 1900. No. 34614 A.

Electric Underground Railway for New York, U. S. A. Illustrated detailed description of the plans as now adopted. 5000 w. Engr, Lond—April 27, 1900. No. 34072 A.

Zurich.

The Zürich Electric Street Railways (Die Elektrischen Strassenbahnen der Stadt Zürich). J. Sigfrid Edström. A well illustrated account of the different parts of this tramway system. 1500 w. Elektrotech Zeitschr—April 26, 1900. No. 34112 B.

THE WORLD IS ITS FIELD.
THE ENGINEERING MAGAZINE

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THE CRISIS IN CHINA. ITS MEANING FOR ENGINEERING INTERESTS.

By Hon. John Barrett, Late U. S. Minister to Siam.

IF there is any one plain fact that stands out with pre-eminent prominence in the present Chinese situation, it is that the material interests of the great industrial nations are identical. In view of immeasurable results, there should be no bickerings, no distrust, and no misunderstanding among such nations as Great Britain, the United States, Germany, France, Japan, and Russia.

Unfortunately, however, selfish considerations, geographical relations, and international jealousies may prevent these leading powers of the world acting in thorough concert and harmony. As corollary, therefore, to the first proposition in regard to community of action among industrial countries, there is no valid reason why Great Britain and the United States, and possibly Japan and Germany, should not unite in forwarding the same policy. If, however, we go on to further elimination, there is absolutely no ground for the United States and Great Britain failing to work together in solving successfully the present Chinese problem.

The preservation of the integrity of the Chinese empire, under autonomous government, is of prime importance to the United States because, as generally recognised, they neither seek nor will accept any Chinese territory under a parcelling out of the Empire. It is no less important to British commercial interests because they have far more to gain from general freedom of trade than from special control of a section of the country—to which other nations would have free access—and restricted or forbidden intercourse with other sections controlled by nations having a less-liberal trade policy.

But beyond all this, larger statesmanship dictates the preservation of Chinese territorial and administrative entity. Division would be only too likely to give rise to bitter and per-

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If there was ever a time in history when the motherland and the ambitious offspring should be united in purpose and action, that time is now in China. Being neither an Anglomaniac nor an Anglophobe, I can make this statement without prejudice. While I am thoroughly convinced that there should be no offensive or defensive alliance between England and the United States in their general relations with the rest of the world, and while I would oppose any formal alliance except in heroic instances, where the life and institutions of the Anglo-Saxon race might be imperilled, I do contend, despite the antagonism of some demagogues and some sensational newspapers, that the interests of the United States and England are almost identical in China.

No man can travel up and down the Asiatic coast from Vladivostock in Siberia and Yokohoma in Japan, to Bangkok in Siam and Batavia in Java, and not be convinced that the commercial and political, or the material and moral, interests of the United States and Great Britain are almost the same. In this matter I speak most frankly and with knowledge of the fact that superficial students of the field and political time-servers may question the truth and wisdom of my observations. This statement, moreover, is submitted with a most friendly feeling towards the policy and purposes of Russia, France, and other countries, which may not commonly be rated as working in harmony with Great Britain. My admiration for the diplomacy of these nations is not in the least limited by my readiness to tell the truth about the relations of British and American merchants and missionaries in all parts of China. Those of us who, either in an official or private capacity, have travelled up and down the China coast from Canton to Tientsin, and back into the interior to Hankow and Chungking, are thoroughly aware that Americans and British, almost without exception, labor along the same lines with harmony of action.

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haps uncontrollable national jealousies and quarrels. And the "white man's burden" is already heavy enough without adding to it the enormous load of the actual direction of the affairs of this huge section of the race. The occidental nations—probably with most helpful intermediary assistance from Japan—must not and cannot shirk the responsibility of inspiring, advising, and to a large degree organising a new and wisely-progressive home government in China. But to the greatest extent possible she should be permitted and led to work out her own new order. Those best informed are most confident of the existence of the necessary elements of stability and progress among the native statesmen of China. The leaven may yet be too feeble of itself to leaven the whole lump, but it needs only fostering care. This, and not the stupendous attempt to raise the mass by outside agency, is the end to which the best efforts of Europe and America should be directed.

Here again, as suggested in an editorial in this issue (p. 899), the engineer—whose interests are greatest—should make his influence felt with his government. Ministers and statesmen have learned to appreciate his importance and to value his advice. It is time for him to learn to appreciate his own power, and to use it.—The Editors.

Let us be fair. If two men think and act alike, why should it not be made known? Why should the truth be covered up for mere political considerations? Whether or not they are brought together because they speak the same language does not determine any different conclusion. The simple fact exists and it cannot be denied. If the marines or sailors from ships of several different nationalities are landed in any Chinese port, you will always find the British and Americans together. Under such circumstances I have repeatedly seen an ardent American-Irishman going about arm in arm with an Englishman or Scotchman, and, if the environment permitted, they would be singing "America" and "God Save the Queen" at the same time! When the Immortalité in Manila Bay saluted the Olympia on August 13, 1898, as the latter, under Admiral Dewey, proceeded to attack the defenses of Manila, I overheard a Fenian Irishman in one of the gun crews of the Olympia call for three cheers for Captain Chichester, of the good British ship. But that is only one instance among a score of others that showed closeness of sympathy in the hour of trouble during the many years that it was my privilege to reside in the Far East. It would be possible to cite illustrations without limit where in Newchwang, Peking, Tientsin, Chefoo, Shanghai, Hankow, Amoy, Foochow, and Canton, American and British merchants, missionaries, and other residents have joined hands to accomplish results and purposes where they had like concern. This did not necessarily involve antipathy for Russians, Frenchmen, and Germans, but, more often than not, caused the representatives of the latter nations to follow the leadership of those of the first two named. At the same time, the most vigorous contentions and debates, which involved the best interests of foreigners, were between Americans and Britishers. They did not unite or disagree simply because they spoke the same language, but because, taking everything into consideration, they had similar interests at stake.

America's supreme concern in China, which appeals to the greatest number of her people, is the commercial opportunity. That is likewise Great Britain's chief concern, and should be that of Germany, France, and Japan. On the other hand, it is doubtless true that Russia's chief ambition is to extend her territorial limits. In time there may evolve a situation where her industrial prosperity will be involved, because Russia must eventually in her development become a manufacturing nation if she would have permanent prosperity. America, it will be admitted the world over, has no desire whatever for territorial aggrandizement. She is on record as being unreservedly opposed to the partition of the empire, to acquiring for herself any port, part, or province of China, and as being committed emphatically to the "open-door" policy. Great Britain is now face to face with a growing sentiment in her own country against any further extension of her imperial domain, and has always led the agitation in favor of the open door. If the war in South Africa would seem to be inspired by a sentiment contradictory to this assertion, it, on the other hand, would appear to mark the limit of conquest which the English people would favor or permit. If any English ministry should now announce a policy of further acquisition of alien lands, its party would probably be defeated if it appealed to the public suffrages. I do not claim to be an authority on English politics, but a study of the current of English opinion would warrant this conclusion. In America the preponderance of unprejudiced opinion is that the United States have taken and are maintaining possession of the Philippines as a result of meeting the unavoidable moral responsibilities growing out of the war with Spain; but the American people would not tolerate for a moment a policy openly in favor of the partition in China or the acquisition of American territory in the limits of Cathay.

Looking candidly into the future, the United States will therefore endeavor, whether in co-operation with Great Britain and other nations or not, to preserve the integrity of the Chinese Empire and prepare the way for a legitimate, untrammelled, material exploitation of China's vast resources. The United States have everything to lose and nothing to gain by the division of China. With China's area intact, America will find markets and opportunities there unrivalled by any yet undeveloped in other parts of the world. Even the most optimistic prophecies of the future of South America and Africa do not rival those that can be reasonably and logically made of China and neighboring portions of Asia. If square miles alone limited the opportunity, this statement might be questioned; but population cuts even a more important figure than area. Millions of people are what make the demand for the manufactured and agricultural products of America and Europe. The population of Asia, moreover, is increasing rapidly, and the more the inhabitants come into contact with the wares of the outer world, the greater grows their demand. The improvement of China's latent mineral resources, of her wide agricultural extent, of her rivers, canals, and harbors, of her city and country conditions, and of her transportation facilities, would be easily measured, but not so inviting, if within the mighty reach of the empire were not uncounted millions of inhabitants.

While it is admitted that the supreme concern of the English-speaking peoples is commercial opportunity, it cannot be out of place, even in a technical magazine, to acknowledge that next to that, or almost rivalling it, is the moral responsibility. Our missionaries have prepared the way for our merchants. For long years the forward movement of Christianity has contended for a betterment of the people. And an extended experience with the missionaries in Siam, who were under my jurisdiction as United States minister, and considerable acquaintance with them in China, Japan, and other lands, gained by travel, have convinced me that our missionary and mercantile interests should work together for the advancement of both foreign and native welfare in the Chinese Empire. It is useless to discuss a new situation in China, where our merchants shall have unlimited privileges and our missionaries shall be curtailed. The missionary societies and chambers of commerce in Great Britain, the United States, and in other Christian countries, should unitedly support their respective governments in insisting upon a re-adjustment of affairs in China, where the rights, lives, work, and property of all will be safeguarded. Let us stand for an "open door" where the engineer and the educator, the merchant and the missionary, can enter without discrimination in favor of one over the other. Then church and commerce will make an irresistible moral and material force that will lead the way to a social and trade development in China which will astonish the world and meet the approval of both white and yellow races.

The present crisis in China induces us to study her people and resources as never before. In striving to ascertain real facts, conservative experts are making their predictions on other grounds than those of imagination. In this connection it is well to emphasize the opinion of many authorities that China's reputed population of 402,000,000 is a limit not warranted by the observations of observing travelers. General William Barclay Parsons, the noted American engineer who went overland from Hankow to Canton and made other excursions into the interior, stoutly contends that there are not more than 250,000,000 people in China. Dr. Morrison, who crossed from the Yangtsze Valley through Yunnan into Siam, holds that the population is exaggerated. Mr. Archibald Colquhoun, who is possibly the ablest living authority on China, has often told me that he did not think that the empire comprehended the figures commonly stated. Mr. W. Pritchard Morgan's engineers, who have recently visited Szechuan, the principal province of China in area and population, state that the estimate of inhabitants should be cut in twain. Missionaries and others who lived long in Peking and in Canton, after comparing the density of population to that of many European and American cities, agree that the large figures usually given are greatly exaggerated. In my own travels, I have never been convinced that China could possibly have over 300,000,000 people. If it is granted, however, that 300,000,000 Chinese occupy her 4,000,000 square miles, and that they are increasing in a natural ratio, the European and American engineers and merchants have before them an opportunity worthy of their best efforts.

The most striking and impressive consideration is that of possible railway construction. These millions must be carried hither and thither, these boundless miles must be connected by trunk and branch lines, the products and wealth of the interior must be brought to the coast, and the imports of foreign countries must be shipped to inland points with the aid of modern facilities for mechanical transport. A picture of railway extension in China, based on possible passenger and freight traffic, cannot yet be accurately painted, but it is a reasonable estimate that China should require in the near future 40,000 miles of railways, instead of 400 miles, as now. If not over 4,000 miles are at the moment planned or contemplated, that is no argument that ten times as much building will not be needed when systematic construction is once begun and the government and the people are favorably disposed to this radical innovation. Against dire prophecies of the financial failure of the Tientsin-Peking line, it has prospered beyond the expectations of all. The fact that in certain parts of the empire some tracks have been torn up, or that fanatical fury has opposed construction, proves nothing against eventual possibilities.

Then follows, in importance, the improvement of the rivers, canals, and harbors. Few countries in the world offer such possibilities as China in this respect. The best engineering skill of England and America will have a field here of supreme effort. Millions of dollars must be expended, and a long time occupied, in opening up the grand canal from Chinkiang on the Yangtsze to Tientsin on the Peiho; the difficult problem of keeping within its channel the frequent floods of the mighty Yellow River, or Hoang Ho, must be met and solved in the near future, if the lives of millions of people are to be saved and a rich area protected from famine and devastation; the numerous obstructions in the course of the great Yangtsze artery must be removed and navigation protected throughout the year for the obvious advantage to local and foreign trade; the lesser waterways, like those of the Sekiang in the south and the Peiho in the north, must be made safe for the regular coming and going of river and coast craft; the harbors and their entrances at Shanghai, Taku, Newchwang and other similar points must be deprived of their "heaven-sent barriers"; roads and highways must be constructed in the neighborhood of the chief cities and into the interior; bridges of modern style and strength must be placed across rivers and canals; the many populous cities must be supplied with electric lights, with water works, with sewerage systems, and their streets must be widened and other corresponding engineering changes instituted; the same cities must be provided and connected with electric car lines; telephones and telegraphs must be extended; mines of coal, iron, copper, gold, and other minerals and metals, known to exist in large and paying quantities, must be opened and worked and their products brought to interior and coast markets; methods of agriculture must be changed to the demands of new conditions; the old style of construction of business buildings, home dwellings, warehouses, and other structures must give way to modern architectural materials.

This is not a fanciful picture. Such evolution from the old to the new is going on with astonishing rapidity in Japan, Siam, India, Egypt, the Straits Settlements, Java, the Philippines, and it will surely come in due time throughout the Chinese Empire. What can be done when a country once moves is supremely well shown in Japan, but I was particularly impressed with the record of Siam during the four years of my residence as United States minister there. In 1898 I saw marvelous changes along the lines summarized above in regard to China which I did not imagine could be accomplished when I first went there in 1894. When we remember that Japan fifty years ago was essentially in the same material state that it had been for three thousand years before, it is not unreasonable to expect a similar advancement in China when the interior shall be opened, a more liberal and progressive administration of law and order inaugurated, and the nations of the foreign world have united to preserve the integrity of the empire and promote necessary reforms. Japan has developed her foreign trade from $30,000,000 to nearly $300,000,000, in approximately thirty years. China's trade is now valued at $333,000,000. This is an increase of 100 per cent. over the figures of ten years ago and 33 1-3 per cent. over the condition in 1898. It would seem, therefore, as if China were beginning to extend her commerce to such figures as would eventually correspond with those of Japan in proportion of trade to population. If this comparison were strictly carried out and Japan's ratio of trade, $7 per head, were applied to China, on a basis of 300,000,000 people, she would have in due course of time the magnificent annual total of $2,100,000,000. This may not be realized for some decades to come, but it must be reached eventually. When we remember that Great Britain's foreign trade averages nearly £20* ($100) per head, and that China's population and demands are rapidly increasing, it is not unreasonable to estimate her future possibilities on a basis of $7 per head. America in 1899 sold to and bought of China, including Hong Kong, products valued at nearly $45,000,000. It is not an exaggeration to state that this total should grow to $450,000,000 in fifty years. A careful examination of the customs returns of China for 1899 shows a remarkable increase along those lines which mean much for a diversified development of manufacturing and agricultural exports from all parts of the world. And from America, the manufactured cotton goods of the southern States, the flour of the Pacific coast and the northwest, the petroleum of the middle States, and the manufactured iron and steel and miscellaneous output of the central west and of the eastern States are finding a widening market in China, and yet the opportunity is in its infancy.

What applies to the United States is also true in corresponding measure of the demand for the products of the industrial countries of Europe, so that they can work in common for the preservation of the Empire's entity and the permanent maintenance of the open door.

Summed up in a few words, therefore, the policy of the United States, supported by engineers, merchants, missionaries, manufacturers, capitalists, and laborers, as well as by diplomatists and statesmen, should include: first, the re-establishment of peace, order, contentment, and prosperity throughout the entire empire, with just reparation for loss of life and property sustained at the hands of the insurrectionary forces; second, the permanent protection of the lives, rights, and interests of foreigners as laid down in the treaties with China; third, the maintenance of Chinese sovereignty throughout an unpartitioned area from Manchuria to the Kwangs and from Chekiang to Thibet; fourth, the lasting practical application in both letter and spirit of the open-door trade principles as laid down in the conventions between China and the foreign powers. If the United States and Great Britain will employ their united moral influence for the achievement of these results and not weaken in any point, they will be supported by Japan, and not opposed by Germany, Russia, and France.

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* Calculated from the total export and import trade. The former is approximately 2-5 and the latter 3-5 of the total.

THE FOURTH ERA OF THE LEADVILLE MINING DISTRICT.

By Thomas Tonge.

LEADVILLE is unquestionably the most important mining district in Colorado when judged by its aggregate production during the last twenty-one years, which has exceeded $250,000,000 worth of ore, by its present great tonnage output, and by its certain vast future production for the next fifty years and more.

Its special characteristics are that the great mines opened within the last few years, both in gold and silver, were discovered and operated by Leadville men and by the expenditure of Leadville or Colorado money—by men who had studied and knew the district and its possibilities, and who had the energy and courage of their convictions. Moreover, the questionable practices of "promotion" and "flotation" are practically unknown; not a single Leadville mine is listed on any stock exchange, and nothing but the ore taken from the ground is looked to for profits. High salaries and expensive offices are avoided and efficient and economical management is the rule. In this way Leadville presents numerous instances of ideal mining, which some other districts could well copy.

Leadville has now entered on a fourth era in its history: The first era was that of placer mining in California Gulch from 1859 to 1869, which attracted many thousands of persons, and during which period millions of dollars' worth of gold were taken out, not included in the $250,000,000 before mentioned. The placer era was succeeded by a period of innocuous desuetude from 1869 to 1879 and by the partial abandonment of the district.

The second era commenced with the discovery, about 1879, of rich lead-carbonate ores running high in silver. This led to the opening up of the wonderfully productive mines on Iron Hill, Carbonate Hill, Fryer Hill, etc., some of which paid millions of dollars in dividends. During this carbonate period thousands of persons flocked to Leadville from the ends of the earth, and millionaires were made almost in a day. The rich carbonate ore deposits, found comparatively near the surface, are now practically exhausted.

The third era dates from the decline in the price of silver, culminating in 1893 with the closing of the Indian mints to the coinage of silver, and the repeal of the silver purchasing clauses of the Sherman act. In the words of Mr. A. A. Blow, M. E., the mining industry of Leadville was seriously crippled, her prestige apparently lost, and the district received a check which even the most sanguine could not help admitting was a case of partial paralysis, with a serious prospect of a total annihilation of her only industry. Silver was then supposed to be her only hope and salvation, and the fall of the white metal was thought by many to be the signal for Leadville's rapid decay and abandonment. The period of depression, however, only served to turn a new page in Leadville's history and to usher in the third or golden era of this wonderful mining district, in the opening up of what is known as the Leadville gold belt, two miles east of the city and embracing Breece Hill, Printer Boy Hill, Florence Hill, and Little Ellen Hill—an area of about four square miles.

BREECE HILL.

The glamour of the wonderful discoveries of the rich carbonate ores in 1879 and subsequent years practically obscured the fame of the gold-placer workings of 1859-1864, which were simply remembered by the older inhabitants as a departed glory and were regarded by some of the new comers almost in the light of a tradition. The decline in the value of silver set some of the practical men to theorising as to the probable source of the gold originally found in the placers of California Gulch, and directed renewed effort to the exploration of the gold-bearing area.

While what is now known as the gold belt on Breece and other hills has been worked on a small scale ever since 1879, it was not worked so vigorously as that portion of the district consisting of Fryer, Carbonate, and Iron Hills, simply because the outcrops of the main veins were more disturbed and altered by atmospheric agencies. On the three hills mentioned the ore was found intact at no great distance from the outcrop, while on Breece Hill the vein had been leached of its valuable contents for a considerable distance. Many attempts were made to reach pay ore in quantity in that vicinity, but the first successful attempt was as follows:

GENERAL VIEW OF LEADVILLE.

Mr. John F. Campion, a practical mining man of considerable local experience, theorised that while the faults of the Leadville district interrupt its known ore bodies temporarily, or displace them, the ore bodies do not thereby terminate, but are continued beyond such faults at other and different horizontal planes. Acting on this theory he commenced exploration work on Breece Hill in 1891, in a shaft now a part of the property of the Ibex Mining Co. He began work himself by taking a lease, with option of purchase, and afterwards admitted some personal friends as partners, the partnership being organised and known as the Ibex Mining Co., with a capital of $100,000. The company is still a close corporation. Pay ore was discovered in August, 1892, but not in large quantities. After further exploration it was concluded that the main ore bodies were deeper and the shaft was sunk another 150 feet, in some places through dolomite sand or lime quicksand, a most difficult, treacherous, and expensive material to pass through. It required two years of steady expense and of the exhibition of the courage born of knowledge before the main ore body was reached, in 1893, since which time the property has produced $13,000,000.

The success of the Ibex Mining Co. led to much development work on Breece and adjoining hills, and a brief mention of the most easterly mine is justified, particularly as the same geological formation evidently continues still further easterly to and beyond the summit of the Mosquito Range or Continental Divide.

The Resurrection Gold Mining Co. is also a close corporation, composed of three Colorado men and capitalised at $500,000. The company owns 240 acres of patented ground on Little Ellen Hill, of which as yet only 33 acres have been opened up. The property was acquired in 1894, since which the following shipments have been made: 1895, 5,000 tons; 1896, 9,000 tons; 1897, 16,000 tons; 1898, 24,000 tons; 1899, 36,000 tons; while if the present rate of output is maintained, there will be 45,000 tons of ore shipped during the current year. The ore has averaged in value $20.27 per ton, 50 per cent. of the value being contributed by the gold, 32 per cent. by the lead, and 18 per cent. by the silver.

According to the statistics of the United States mint, the annual

THE PROPERTY OF THE IBEX MINING COMPANY.

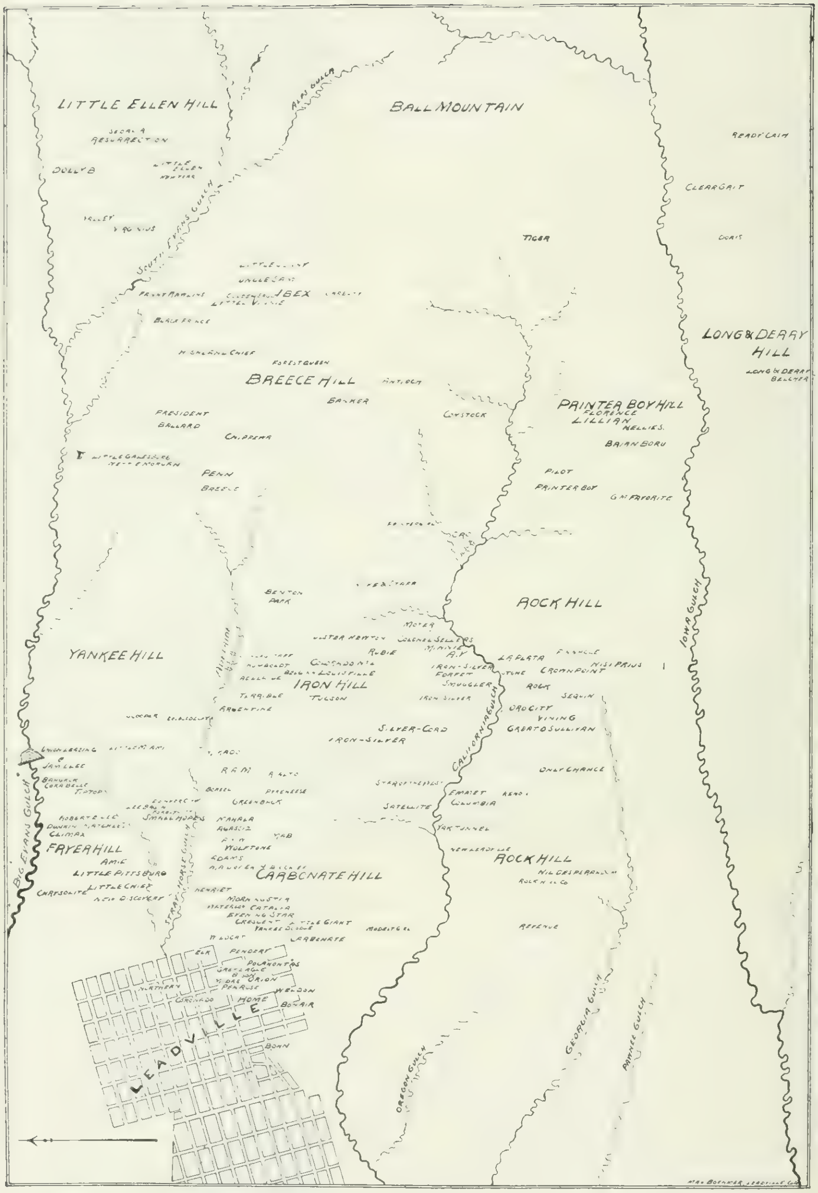
gold output of Leadville has risen from $262,629 in 1892 to $2,183,332 in 1899; each succeeding year will witness marked further advance.

The fourth era may be called the composite era, in which gold, silver, lead, copper, iron, zinc, and bismuth are profitably mined and treated.

Almost simultaneously with the development at the eastern end of the district commenced the development of what is known as the "down-town" section, towards the western end of the district, followed by other work on Rock Hill on the southwesterly continuation of the known ore chutes of Iron Hill. The development of the down-town district dates from about 1890, with the sinking of the Sixth Street shaft, followed by the sinking of the Penrose, Elk, Bon Air, Hussey and Bohn shafts, ranging from 500 to 550 feet deep, all revealing the continuation in a southwesterly direction of the characteristic Leadville formation, which yielded such large quantities of rich carbonate ore in Carbonate, Fryer, and Iron Hills. The ores of the down-town district—and, in fact, the bulk of the present output of Leadville, outside the gold belt—consist of iron and lead sulphides carrying silver and more or less zinc, and of iron oxides carrying silver.

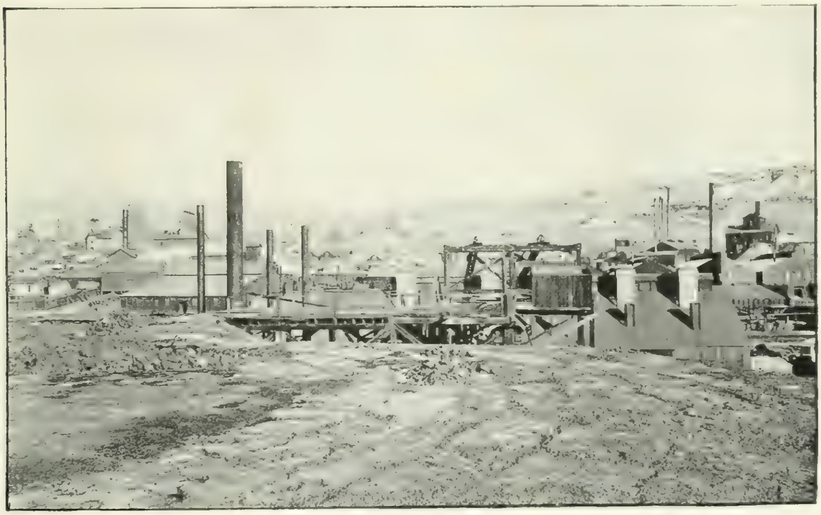
NO. 3 SHAFT, RESURRECTION GOLD MINING CO.

Several of the down-town shafts had shipped considerable ore prior to 1893, when the fall in the price of silver and lead caused a cessation of operations. Just as the district was beginning to recover from the effects of the events of 1893 and to adapt itself to the new conditions, serious labour troubles took place in 1896 in the form of a strike of the miners, during which the mines were closed, pumping ceased, and the workings became filled with water. In 1898 a pump-



MAP OF THE LEADVILLE MINERAL DISTRICT.
By Max Boehmer, Leadville.

ing association was formed by the owners of about twenty of the down-town mining properties, and pumping was begun in the fall of 1898. The main pumps were installed in the Penrose and Bon Air shafts, while existing pumps in the Bohn, Northern, and Coronado shafts co-operated. For quite a number of months an aggregate of 4,000 gallons per minute were raised, the entire operation costing more than $100,000. After the district was once drained the pumping became normal, viz., about 1,200 gallons per minute, to the cost of which each member of the pumping association contributes rateably, based on the value of the ore taken out monthly. This down-town section is now producing nearly 20,000 tons per month, yielding a minimum profit of $5 per ton after mining and smelting.



THE DOWN TOWN PROPERTIES.

Space does not admit of a detailed statement as to the exact geology of the various parts of the Leadville district, which has been exhaustively dealt with by Professor Hayden, Professor Emmons, and others, and to-day is practically an open book. Speaking generally and of that part of the district known as the Leadville Basin, the rocks lie flat and the ore is found in blanket veins. The rocks occur in the following order: directly under the wash and nearest the surface is the white porphyry; next comes the limestone, then quartzite, then granite. The largest bodies of ore are found in chutes or channels having a northeasterly and southwesterly direction, lying on the planes of contact or stratification of the different rocks, and often to a large extent replacing the rocks themselves. No work on any ore channel in either direction has ever shown its end. It is not unusual to find the ore bodies of great thickness and extent. For instance, at one time in the A. Y. & Minnie Mine, on Iron Hill, a solid body of ore, free from waste, was blocked out 941 feet long, 176 feet wide, with an average thickness of 67 feet, such ore averaging 48 ounces of silver per ton and 15 per cent. lead.

The ore channels, as a rule, have well defined boundaries or walls laterally. Longitudinally they have been followed for lengths up to 6,000 feet. A new discovery of a channel in virgin ground in Leadville generally means a great discovery, and persons making such realise very handsome returns.

NO. 2 SHAFT, RESURRECTION GOLD-MINING CO. ALTITUDE, 11,700 FEET.

At the extreme eastern end of the present developed district No. 2 shaft of the Resurrection Mine passed through the following strata: 400 feet Webber grit, 150 feet Webber shale, 100 feet white porphyry, 125 feet blue limestone, 25 feet parting quartzite, then white limestone. The ore was struck at 650 feet from the surface, just below the white porphyry and above the blue limestone, and again in the white limestone beneath the parting quartzite. On Carbonate Hill and Iron Hill the Webber grit and shale have been eroded.

The gold-bearing ores on the gold belt are in continuation of the same ore bodies previously discovered further west, and are a part of the system in which ore chutes have evidently been enriched in their gold contents by the influence of the porphyry dykes. The ores of the gold belt are found at the contact plane of the blue limestone with the eruptive rocks and in lower horizons of the limestone and also in the porphyry dykes. The ores in the gold belt consist of silicious ores, carrying gold and silver, and a small percentage of lead and sulphide ores, also carrying a small percentage of copper.

At the extreme westerly end of the present developed district, Revenue Shaft No. 1, when I was there on May 11, was down 621 feet, having passed through the following strata: "wash" and "lake bed," 325 feet; white porphyry, 220 feet; contact, 6 feet; blue lime, 20 feet; gray porphyry, 50 feet. It was then expected that possibly another 100 feet of gray porphyry would be encountered, to be succeeded by blue lime. On this point, one of the leading local mining experts, Mr. Max Boehmer, M. E., says: "In many places ore is found beneath a sheet of gray porphyry, which lies near the middle of the blue limestone," and the gray porphyry in the Revenue shaft was regarded as such an intrusive sheet in the blue limestone.

The Leadville of to-day is entirely different from the Leadville of twenty years ago, or even of ten years ago. While in 1880 the mining operations were practically confined to Carbonate, Iron, and Fryer Hills, at the present time the mines extend from the Resurrection on Little Ellen Hill on the east, to the Revenue on West Rock Hill on the west, a distance of seven miles, with every indication that further development both east and west will encounter similar ore bodies.

Since 1880, and particularly since 1890, the problem of handling the low-grade ores has been very successfully solved, and the result is an enormous increase in the tonnage output, which ten years ago did not exceed in the average 1,400 tons daily, as against an average of more than 3,000 tons to-day. The change has been brought about by various causes operating in the direction of increased economy; the chief of these may be summarised as follows:

(1) In 1880 the average smelting charge was $30 per ton, in 1890 $10 per ton, while at the present time it is about $5 per ton.

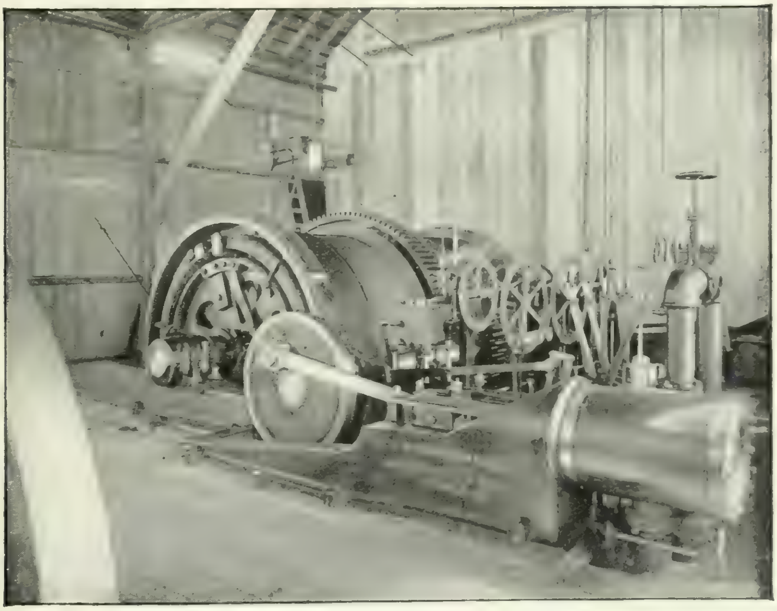
In 1880 the Leadville smelters had small furnaces, each of a daily capacity of 30 to 35 tons, with low blast, short flues, low stacks, and no devices for settling the slag. The short flues and low stacks involved great loss of values in dust and fumes. Moreover, the chemical mixtures in the furnace were not then as well understood as now. For the above reasons it was not then possible to make a clean saving of the values. At the present time the smelter furnaces have each a daily capacity of from 100 to 150 tons, with high blast, long flues, and high stacks, preventing loss of values in dust and fumes, with additional devices looking to increased saving in values, by means of all of which the former losses in value have been reduced considerably more than 50 per cent. The smelter dumps accumulated prior to 1890 have since been more or less re-smelted at a profit.

WOLFE TONE SHAFT, A. M. W. MINING CO.

The fuel used by the Leadville smelters in 1880 was charcoal of local production, and coke, hauled from Pennsylvania to the nearest railroad point and from thence by wagon to Leadville. The smelters now obtain coke in unlimited quantities from Colorado ovens at a tithe of the former cost of Pennsylvania coke, while charcoal is largely dispensed with. The cost of iron, fire brick, and other smelter supplies has also been proportionately reduced.

(2) The cost of steam coal in Leadville to-day shows a reduction of 75 per cent., as compared with 1880, and of 50 per cent., as compared with 1890.

(3) Leadville is essentially "a wet camp." The cost of pumping has been much reduced owing to the improvements in pumps. Formerly ordinary single or duplex pumps were used, with a capacity of 150 to 400 gallons per minute, whereas to-day compound and triple-expansion pumps, some of them with a capacity as great as 1,500 gallons per minute, are the rule. The cost of pumping has thereby been reduced 50 per cent.



STEAM HOISTING PLANT FOR 1,200 FEET.
Little Johnny, Ibex Mining Co.

(4) Since 1880 the freight rate on ores from the Leadville mines to the smelters at Denver and Pueblo has been reduced considerably more than 50 per cent., some of which reduction took place since 1890.

(5) Freight from the mines to Leadville smelters via the various local railroad spurs, as compared with cost of previous wagon haul, has been reduced more than 50 per cent. within the last two years.

(6) The cost of explosives, candles, and other mine supplies during the last twenty years has been reduced more than 50 per cent., a part of such reduction having taken place during the last ten years.

These things have brought within the range of profitable production an immense tonnage of ore which formerly could not be touched. In 1890, while the sulphide bodies were more or less opened up, only the very best grades could be mined, owing to the heavy smelting and other charges then prevailing. Neither the gold-belt nor the down-town mines were producers in 1890. Since that time, as above shown, radical reductions in cost of mining and treatment have so changed the conditions that sulphide ore, which could not be handled profitably when silver was 80 cents per ounce, yielded a profit several years later, when silver had dropped to 60 cents per ounce, and ores which were commercially valueless a decade ago now yield a steady margin of profit.

The easy-going and carelessly extravagant ways of 1880 and subsequent years have also been succeeded by an era of experienced, judicious, and rigidly economical management, to the great advantage of the mine owner and investor. There is no place in the United States where mining has been brought down to a more scientific and economical basis than it has at Leadville. The low cost of production at some mines is simply phenomenal. For instance, one company (a close corporation of several Leadville men, capitalised at $100,000)

RAILROAD SWITCH AT THE NO. 2 SHAFT, RESURRECTION GOLD-MINING CO.

during 1899 mined and placed on the cars more than 50,000 tons of ore at an average cost of $3.16 per ton, and has paid $200,000 in dividends since September, 1898.

A considerable quantity of low grade ore is mined simply for fluxing purposes and its low value has necessitated the most economical operation. As above shown, the fall in the price of silver has been more or less compensated for by subsequent improved, modern, economical appliances in both mining and ore treatment, reduced freights, etc.

BIMETALLIC SMELTER.

Leadville is well equipped with smelting facilities. The American Smelting & Refining Co. has three first-class plants at Leadville, viz., the Arkansas Valley Smelter, with a capacity of 20,000 tons of ore per month; the Union Smelter, with a capacity of 5,000 tons of ore per month, both using lead as the collecting medium, and the Bimetallic Smelter, with a capacity of 10,000 tons per month, with the largest cupola pyritic stack in the world, producing copper matte. These smelters furnish employment for between 800 and 900 men. About 50 per cent. of the local ore is treated at these plants, the other 50 per cent. being shipped by railroad to the smelters at Denver, Pueblo, Durango, and even Salt Lake City, as a desirable mix with other characters of ore.

Another important factor in the recent development of the district has been the building of many miles of track by the Denver & Rio Grande Railroad and the Colorado Southern Railroad throughout the district, reaching almost every important mine and thus dispensing with expensive wagon haul over steep and rough mountain roads. The fact that many of the mines can now empty the ore from the mine cars directly into the railroad cars for shipment to the smelters, and the resulting reduction of cost of freight, has alone brought within the range of profitable production large bodies of low-grade ores which formerly were left untouched.

A special feature of the last few years has been the organisation of close corporation companies by Leadville men of local mining experience, with their own capital, for the leasing and operating of properties, subject to royalties. They have been phenomenally successful financially, largely by reason of competent and experienced management.

From twenty-five to thirty of the Leadville mines produce more or less manganiferous ore, in the form of oxide of manganese, the ore running about 33 per cent. manganese. When this ore contains sufficient silver to pay it is shipped to the local smelters; when deficient in or absolutely without silver it is shipped to the steel works for use in the manufacture of Bessemer steel. The Colorado Fuel & Iron Co. in its steel works at Pueblo uses about 25,000 tons per annum of these Leadville manganese ores for making spiegel. In 1897 35,000 tons of these ores were shipped from Leadville to the Illinois steel works at South Chicago, Ill., a distance of over 1,100 miles, and similar large quantities have since been shipped annually.

Some of the Leadville mines have always produced more or less zinciferous ores, which involved such comparatively high treatment charges at the smelters as to make them unprofitable. At the A. Y.

THE ARKANSAS VALLEY SMELTER.

& Minnie Mine, to avoid this difficulty, in former years the ore was crushed and the zinc contents separated from the silver-lead contents by means of jigs. As the zinc tailings could not be allowed to choke the adjoining stream, the then unmarketable article was impounded until a dump of 150,000 tons had accumulated. In the early part of 1899, when zinc was over 6 cents per pound, a shipment of crude zinciferous ore from the Moyer Mine at Leadville was made to Belgium, via Galveston, followed by others, several thousand tons being so shipped during last year.

In October, 1899, two mills, one a stamp mill and the other a roller mill, each of the capacity of 30 tons, were equipped with Wilfley separating tables and commenced to treat zinciferous ores running from 30 to 35 per cent. zinc, 8 to 14 per cent. lead, and from 4 to 6 ounces of silver. The Wilfley table is the first appliance to separate such ores successfully, there being two products, (1) the zinc, (2) the lead, silver, and iron. The lead, silver, and iron product goes to the Leadville smelters, where it is very desirable for flux. From October, 1899, to April 1, 1900, these two mills produced 7,500 tons of separated zinc ore, about two-thirds of which were shipped to Belgium, via Galveston, some to the zinc works at Iola, Kan., Mineral Point, Wis., and to Indiana. The purchasers of the zinc do not pay for the small gold and silver values contained therein. It has not yet been absolutely demonstrated whether the stamp mill or the crushing roll is most suited for this ore. In the meantime a trial lot of 300 tons from the old zinc tailing dump of the A. Y. & Minnie Mine has been purchased for zinc works in Canada, with possibility of the entire dump being also purchased if the experiment is a success. As there are probably 1,000,000 tons of zinc ores now in sight in Leadville, in the form either of zinc tailings from former mills or of crude ore formerly regarded as waste, now in the dumps of the old properties, or in place in the underground workings ready for stoping, the indications are that the question of the profitable mining and treatment of the zinc ores of the district will be satisfactorily solved in the near future.

Another recent product of Leadville is ore carrying about two ounces in gold per ton and a high percentage of bismuth. The ores of a number of the mines in the gold belt carry more or less bismuth, which the Colorado smelters have no means of saving. In one mine, however, the percentage of bismuth is sufficiently high to justify shipping to Europe. Small shipments were made last year, and in April, 1900, two shipments, aggregating 40 tons, were made to reduction works in England, specially equipped for extracting the full values from such ores. Further shipments are about to be made.

For 1899 Hon. George E. Roberts, Director of the U. S. Mint, credits Leadville with an output of gold, $2,183,332; silver (coinage value), $9,383,918; lead, $2,174,876, and copper, $1,228,463, or a total of $14,970,589, to which must be added probably about $600,000 for zinc, manganese, and bismuth. All these figures will be materially increased for the current year.

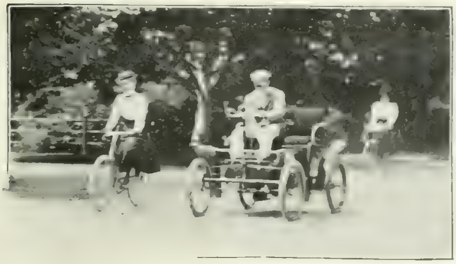
To-day there are over 4,000 miners at work in and around Leadville, the daily output of ore exceeds 3,000 tons, the average value of which ranges from $10 to $20 per ton, this average being materially lowered by the large quantity of low-grade iron ore absolutely necessary as a smelting flux, which low-grade ore nets from $3 to $6 per ton from the smelter. Every ton of ore, however, shows a steady margin of profit and the great tonnage represents large sums.

Notwithstanding its past great production, the district is as yet only in its infancy. It is capable of indefinite expansion, as the local ore-bearing geological formation extends beyond the Resurrection Mine easterly into Park County, on the eastern slope of the Mosquito Range, the Continental Divide, and westerly beyond the Revenue Shaft on West Rock Hill to the Arkansas River, constituting an ore zone at least 20 miles long and several miles wide. Outside the above mentioned belt, and within a few miles of Leadville there is land still belonging to the Government, and therefore obtainable on the usual nominal terms, in which, with capital, gold and silver ore in paying quantities could practically be guaranteed. To prospect such ground, however, requires courage and money, while if pumping is involved the cost is indefinitely increased. The expansion development, therefore, proceeds somewhat slowly, but in no mining district of the western States are the results of intelligent, judicious development work so sure.

It is only a matter of time when development work will extend beyond the present east and west termini of the shipping zone, while within the present ore-shipping district are considerable areas, more particularly south of California Gulch, as far as Empire Gulch, and in the down-town district and under the very town itself, where shafts now being sunk are morally certain to encounter the continuation of the known ore channels. The permanency of Leadville is absolutely assured, and all present indications are that there will be profitable mining in the Leadville district a hundred years hence.

HEAVY MOTOR VEHICLES FOR ROAD SERVICE.

By Fred W. Maynard.



IN America and on the Continent engineers have confined themselves almost exclusively to the construction of the lighter passenger cars, but in England the heavier type of auto-waggon has received the greater attention. It has not, however, been until the closing years of the nineteenth century that practical success in the manufacture of these self-propelled freight vehicles has been attained. This undoubtedly is in great measure due to restrictive legislation, and in earlier times to the rudimentary condition of the engineering industry, the imperfect state of the roads, and hostile public opinion as represented by the land-owning and horse-breeding classes.

The general design of the most notable steam vehicles at present on the English market will be seen, from the illustrations provided, to differ very considerably. Experience is gradually shewing the necessity of economy and simplicity in constructional details, for whereas some of the vehicles contain air condensers fitted with elaborate radiating arrangements, air-circulating fans, induced draught fans, and various engine, boiler and other refinements, with attendant complications, in the more successful types a steady progress towards fewness and simplicity of parts, availability of the motor for various employments, ready accessibility, durability of construction and centralisation of controlling arrangements, is becoming more and more manifest. My former paper summarised the general principles of construction characterising the best accepted practise. It remains to consider more specifically the vehicles put upon the market by the leading makers of Great Britain.

The extreme length of the drays ranges from a little under 16 feet to slightly over 18 feet, the platform area available for loading varying from 56 to 71 square feet, according to the disposition of the

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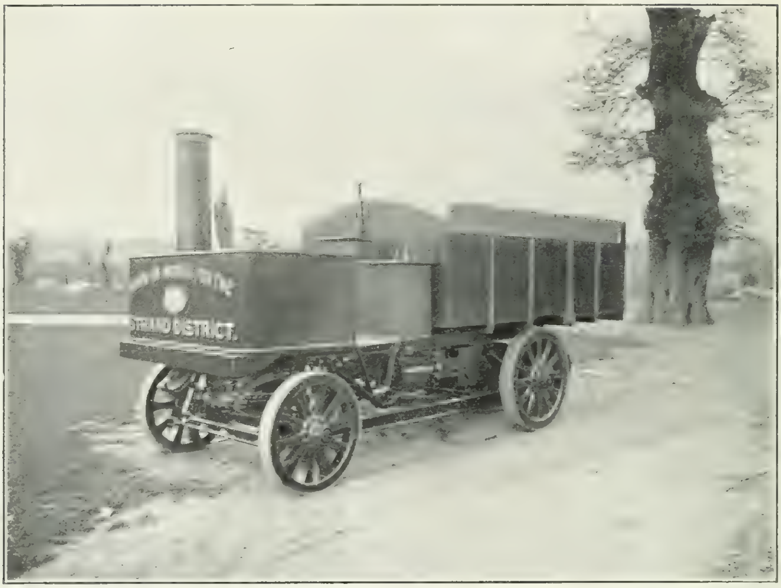
Mr. Maynard's first article appeared in THE ENGINEERING MAGAZINE for August, 1900.



THORNYCROFT STEAM VAN AS USED BY THE STRAND BOARD OF WORKS.

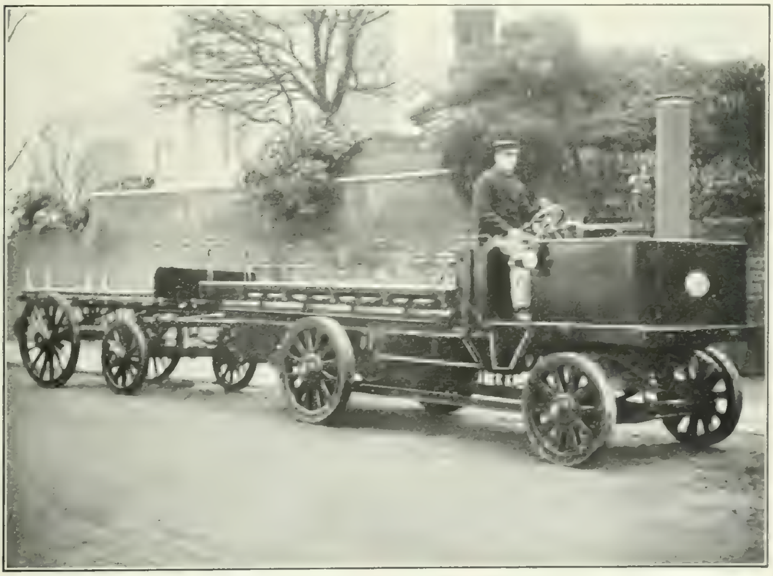
boiler and machinery; the extreme width is limited by the English law to 6 feet 6 inches. The framing is almost without exception of channel steel; the wheels are either of the military type, with metal naves, oak spokes, and ash felloes, or are built up entirely of iron or steel; the latter are, however, not to be recommended, the jars to which they are continuously subjected soon shaking them to pieces, a metal wheel naturally not possessing the same resiliency as one in which wood forms an integral part. As one firm of builders has made a specialty of "dished" wheels for their motor vehicles, it will not be amiss to state that in an excellent article which recently appeared in the *Automotor,* Mr. H. E. Wimperis, Wh. Sc., clearly demonstrates that, however great their advantages may be for the rolling wheels of horse-drawn vehicles, this system of construction is quite unsuitable for the driving wheels of motor-waggons, in which the strains and stresses are of an entirely different character.

As the essential features of a motor dray are strength, lightness and the concentration of high power in small compass, it is not surprising to find that one of the most successful specimens of the modern light road locomotive is the Thornycroft steam waggon, designed by that eminent engineer, Mr. John Isaac Thornycroft, F. R. S., M. I. C. E., M. I. N. A. His many years' practical experience in such high class engineering as torpedo-boat construction naturally enabled him thoroughly to grasp and overcome the peculiar problems of road locomotion.

A detailed description of the Thornycroft steam waggon may therefore prove of special interest.

This vehicle is 17 feet 6 inches long by 6 feet 6 inches extreme width across platform. The wheel-base is 9 feet 11 inches longitudinally and 5 feet 6½ inches (center to center of tyres) transversely. The platform is 12 feet ½ inch long by 5 feet 7½ inches wide, and has 68 square feet of available surface for carrying goods. The height of the platform is 3 feet 11 inches when light and 3 feet 9½ inches when loaded with 3 tons; the frame is of channel steel throughout, and is supported upon the axles by ordinary laminated bearing springs; attached to the under side of the rear springs are axle-boxes somewhat of locomotive type, in which the driving axle turns.

This driving axle, which is made from heavy-section forged-steel shafting, affords a good example of the great strength of the vital parts of the mechanism; although required to transmit only 35 horse power as a maximum, it is the same size as a shaft transmitting some 120 horse power at 120 revolutions per minute, this heavy construction being necessary to withstand the reversal of stresses accentuated by



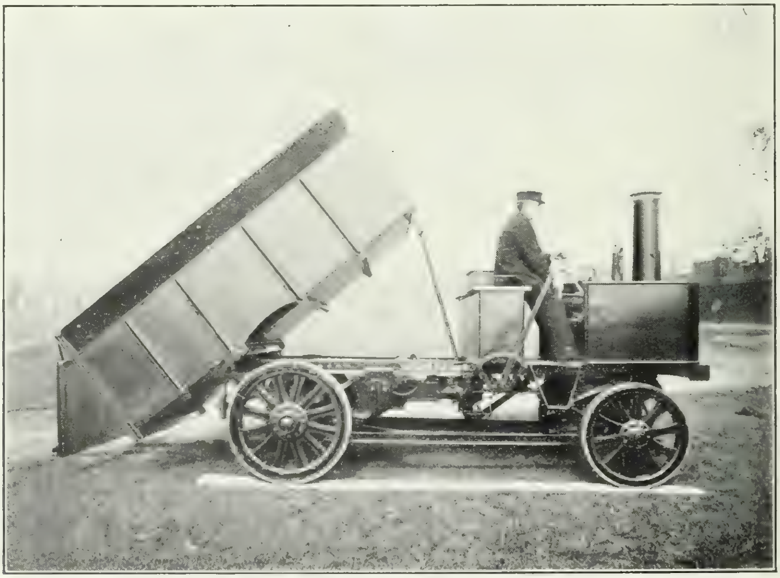
THORNYCROFT LURRY, WITH TRAILER.

Thornycroft Steam-Waggon Works, Basingstoke.

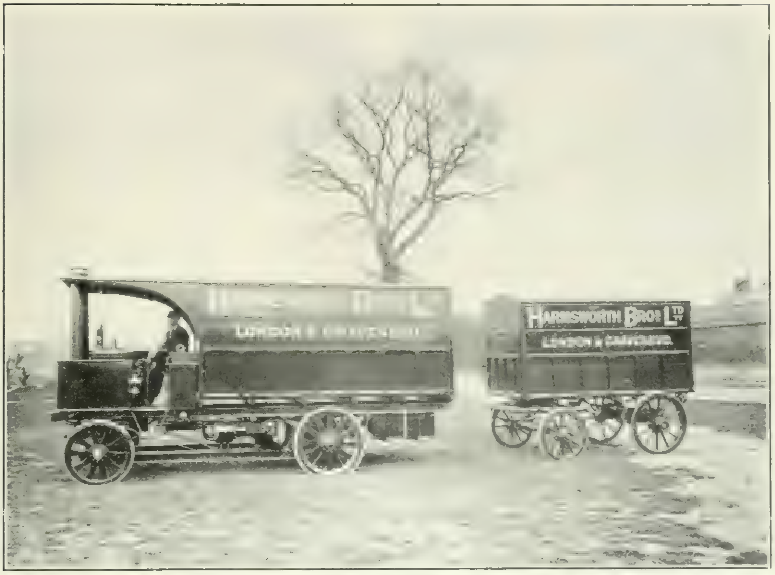
the shocks and jars when running on ordinary roads, to ensure immunity from break downs, and strength to withstand prolonged wear and tear—in short, this vehicle to carry heavy loads resembles in many of its scantlings those of a traction engine.

The wheels, which are of the military type, with metal naves, are stoutly built with oak spokes, ash felloes, and broad and thick steel tyres. The front steering wheels are 2 feet 10 inches in diameter, with tyres 4⅜ inches wide, and are pivoted on Ackermann's system, controlled by worm gearing and a hand-wheel; this steering gear, while having all strains self contained, allows free play to the fore bearing springs; the driving wheels are 3 feet 3 inches in diameter, with tyres 5¾ inches wide.

The boiler, which is placed in front of the driver, is of water-tube type, of annular design, centrally fired from the top and having the fire completely surrounded by tubes which connect the upper (steam and water) annulus with the bottom vessel, the fire being carried in the hollow of the lower annulus in such manner that the tubes are preserved from contact with the ignited fuel. Baffle plates extending about one-third the circumference of the boiler are used to prevent the direct escape of the fire gases, the flame having to find its way on all sides through the narrow spaces left between the water tubes. The fire is regulated by a vertical damper in the ashpan, and the lid covering



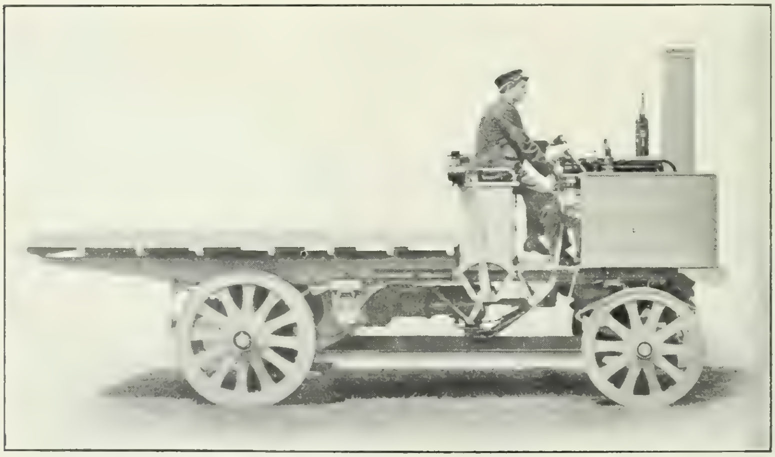
THORNYCROFT VAN, TIPPED FOR UNLOADING.



STEAM DELIVERY VAN AND TRAILER.
Steam Carriage & Waggon Co., Ld., Basingstoke.

the central stoking opening in the upper annulus. The necessary draught is created by the exhaust blast. Ample clinkering and cleaning arrangements are provided. Very light top and bottom covers with special steam joints permit of easy and rapid internal examination of the boiler. The tubes are readily cleaned inside and out, and when necessary the boiler can be re-tubed in position. The heating surface is 83 square feet, the grate area 2.4 square feet; the working pressure is 115 pounds per square inch, and the test pressure 350 pounds per square inch. The fuel recommended is steam coal or coke, but provision is made for the substitution of a liquid-fuel burner. Two safety valves are fitted, of which one, set at 5 pounds above working pressure, discharges invisibly and silently from the funnel; the other, rising to a pressure 10 pounds higher, blows directly into the air in full view of the driver, and thus at once draws his attention to the excess of pressure should the first fail to act. The main feed is by a pump, driven direct from the engine shaft by worm gearing, and any excess of water is returned to the feed tank by hand regulation. The suction and delivery valves of the pump are instantly accessible. The auxiliary feed is by a self-starting injector, so designed as to permit of cones being withdrawn and examined while boiler is under steam. All mountings are of the highest class, a matter of the greatest importance where, as in this case, absolute steam-tightness is so essential.

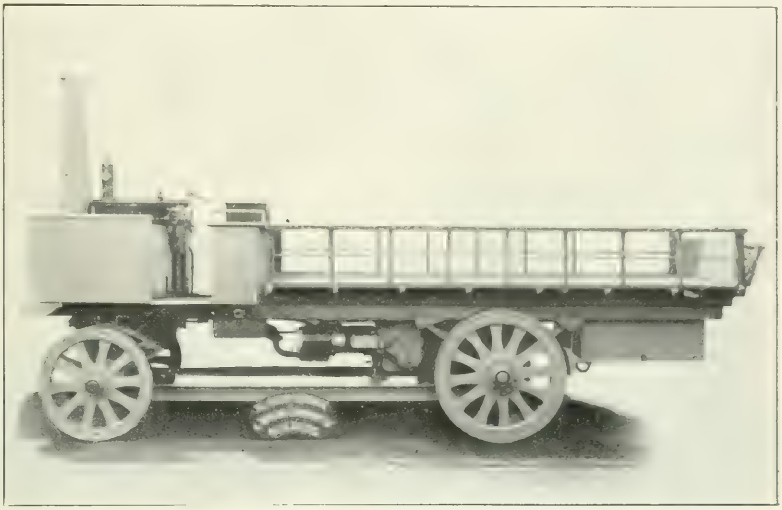
The engine, which is suspended from the channel-steel underframe from three points, in such manner as to be relieved from strains due to any "winding" or distortion undergone by the frame, is horizontal, compound, reversing, with cylinders 4 inches and 7 inches diameter by 5 inch stroke; it is entirely enclosed in a dust-proof and oil-tight casing containing oil, allowing of the "splash about" method of lubrication, as employed in the Willans, Westinghouse, and other quick-revolution engines; the cost of oil used is but a few shillings a month; access is easily gained to every part. Ample bearing surfaces are provided to ensure durability in continuous running, so that adjustments are needed only at intervals of four to six months. A constant-lead radial valve gear is fitted, having balanced valves below the cylinders, thus giving effective drainage and permitting of any degree of "linking up" or reversing, enabling the power to be varied within wide limits, from 5 to 15 indicated horse power, with very great economy. At 440 revolutions per minute, 20 brake horse power are developed; with the low-speed gear in use it runs up to 770 revolutions per minute, giving an effective brake horse power of 35. For its power this motor is very light, weighing under 5 hundredweight and measuring only 3¼ by 2½ by 1½ feet. The engine can be disconnected from the counter-shaft and, running freely, without propelling the vehicle, may be employed in driving agricultural, pumping, sawing, hoisting and other light machinery if so required.



THORNYCROFT STEAM LURRY, 3½ TONS.

A condenser is dispensed with, the exhaust steam passing through a simple form of feed heater (which acts also as a silencer), before reaching the blast nozzle at base of funnel, where it is super-heated and passes away as an invisible vapour under all conditions of atmosphere.

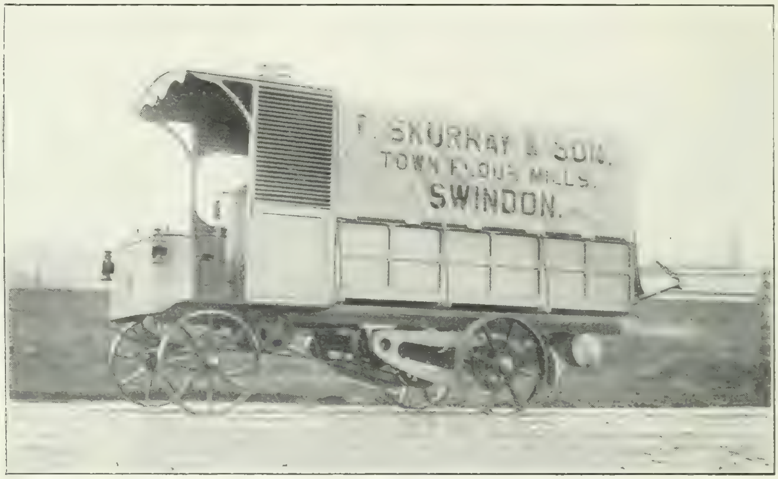
The transmission is chainless. Two pinions are loose upon the engine shaft, either of which engages with and locks into one of two machine-cut tooth-wheels upon one section of the counter-shaft. The counter-shaft is in three distinct pieces; the first of these is attached to the channel-steel under frame and is driven by the engine; the third is borne in bearings carried by a bracket supported upon the perch-frame and carries a pinion gearing with the double helical spurring on the differential-gear case upon the driving axle. These first and third pieces are connected by a pair of specially-designed universal joints, which permit also of a transverse sliding taking place; these joints, being entirely enclosed, are dust-proof and oil-retaining, and are provided with large rubbing surfaces, thus ensuring durability.


THORNYCROFT "LONG FRAME" WAGGON.

Between the extremes of no load and a "bump," with full load, there is a spring motion of 6 or 7 inches, and this is taken up perfectly by the device described, without interference with the continuous torque exerted on the road wheels, and without in any way straining the vehicle.

The differential gear is carried on the rear axle, which turns in this vehicle; the rear wheels are driven by flat springs attached to the main axle on the "off" side, and to the sleeve of the differential gear at the "near" side, these pressing against suitable projections from the felloes. In this way the driving wheel spokes are placed in much the same condition of service as in horse-drawn vehicles, and a yielding connection is obtained between the driving axle and road wheels.

The ratios of gearing between the engine and the driving axle are 10.1 and 17.7 to 1. Although on good roads gradients of 1 to 12 can be mounted with the normal or high-speed gear, on occasions when a greatly increased driving effort is required the slow speed gear is used, the vehicle having carried a load of 3½ tons up a gradient 1 to 6 without difficulty by its aid. On all ordinary gradients 5 or 6 tons can be taken, 3 or 4 tons being carried by the vehicle itself and the remainder on a trailing lurry.



A MILLER'S DRAY.
By T. Coulthard & Co.

Powerful brakes are fitted, acting on the tyres of the driving wheels by means of a pedal in front of the driver, while the reversing of the engine provides a second brake for emergencies.

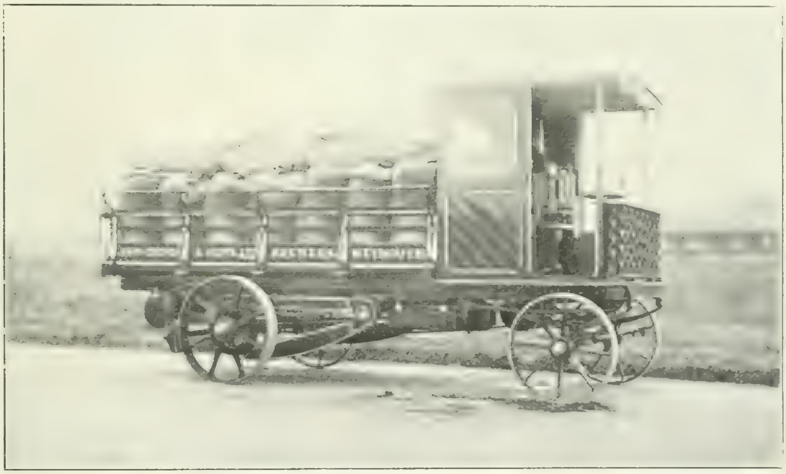
Two water tanks, the capacity of which is 160 gallons (ample for a run of 15-20 miles), are carried; one forms the driver's seat and the other is attached behind the driving axle. The fuel bunkers, having a capacity of 5¾ hundredweight of coal (sufficient for a full-load run of 40-50 miles), are placed in front and at the sides of the boiler, thus protecting it in the event of collision.

The vehicle is entirely controlled by the driver from his seat on the "off" side, which he has no need to leave, all the starting, reversing, steering, brake, and feed levers being immediately to his hand, while the pressure and water gauges are in front of him, without obstructing his view ahead.

The following list includes all other recent makes of English heavy motor waggons; the illustrations serve to supplement the description in the text and to give an adequate idea of the general construction and appearance of these waggons.

1. The "Coulthard," made by T. Coulthard & Co., Ld., Preston, Lancashire:

Description.—Carries 2 tons, generator and motor in cab; steering, Ackermann's; platform, 10 feet 5 inches by 5 feet 5 inches, giving 56 square feet loading area; boiler, "Leyland" fire-tube; working pressure, 225 pounds; fuel, kerosene; engine, triple-expansion, uni-direction, vertical; cylinders, 2¾ inch, 4⅛ inch, and 6 inch diameter by 5 inch stroke; develops 14 brake horse power at 500 revolutions per minute; lubrication, graphite; condenser is carried in front of cab and consists of vertical tier of Row indented tubes; transmission, spur gearing to intermediate shaft, actuated by clutches; final drive by Renold's "silent" chains and chain wheels attached to rear drivers; ratios of gearing, 7, 11½, and 19½ to 1 forward, and 27.4 to 1 reverse; wheels, entirely of iron; brakes, band-brake on second-motion shaft, shoe-brakes on driving wheels, and reverse; capacity of water tanks, 84 gallons; of oil tank, 22 gallons.



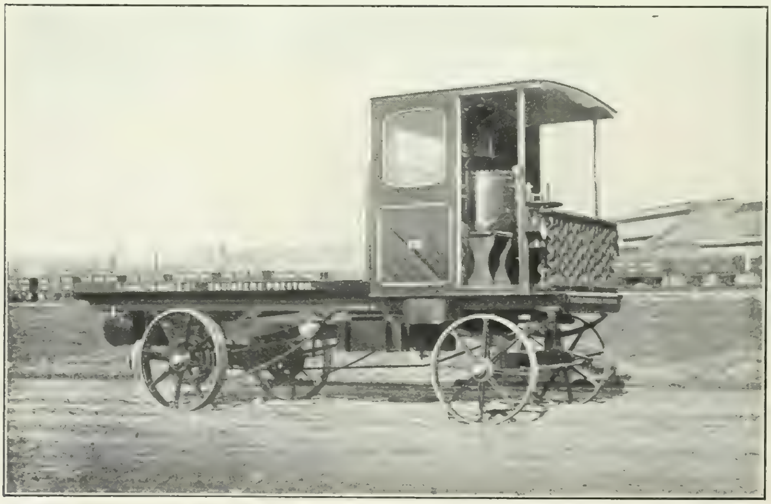
BREWER'S DRAY.
By T. Coulthard & Co., Preston.

2. The "Leyland"; makers, The Lancashire Steam Motor Co., Leyland, Lancashire:

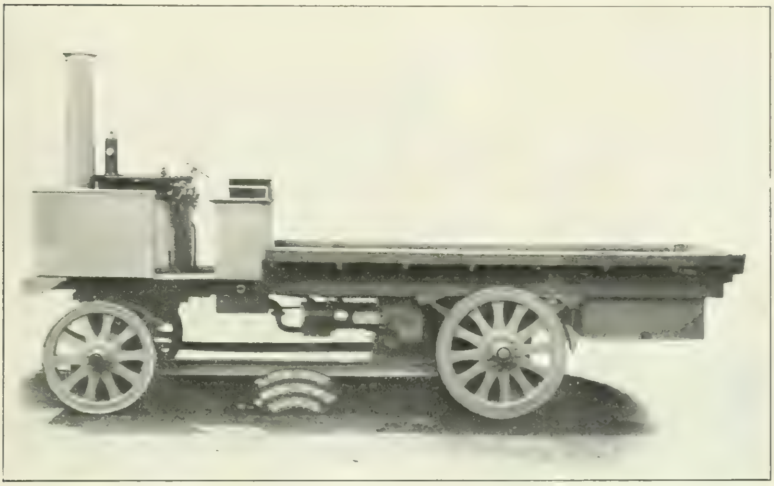
Description.—Carries 4 tons; generator and motor in cab; steering, Ackermann's, with usual connections; platform, 12 feet 6 inches by 5 feet 8 inches, giving 71 square feet loading area; boiler, "Leyland" vertical, fire-tube; working pressure, 200 pounds; fuel, kerosene; burner, "Leyland"; engine, compound, vertical, enclosed; develops 14 brake horse power at 400 revolutions per minute; lubrication, automatic; condenser, "Row" tube, on top of cab; transmission, by chain to second-motion shaft, and again from it to the road wheels; ratios of gearing give three speeds, 1½, 3, and 5 miles per hour; wheels, of military type, with metal hubs; brakes, both band and shoe brakes are provided; capacity of water tanks, 40 gallons; of oil tank, 15 gallons.

3. "The Mann"; makers, Messrs. Mann, Leeds:

Description.—This, like all the following machines, departs, to a certain extent, from the general lines of preceding vehicles, being a combined tractor and trailer. To all intents and purposes it is a small traction engine, with a lurry platform carried partly on the rear water tank and partly on two wheels, which run loose side by side of the driving wheels upon the rear axle; by means of two pieces, these rolling or loose lurry wheels can be connected to the drivers, thereby greatly increasing the adhesive power and giving a total tyre width of 11 inches. The platform measures 12 feet by 6 feet 4 inches, and carries 4 tons; steering, by means of worm and quadrant; boiler, loco-



STEAM LURRY.
By T. Coulthard & Co.



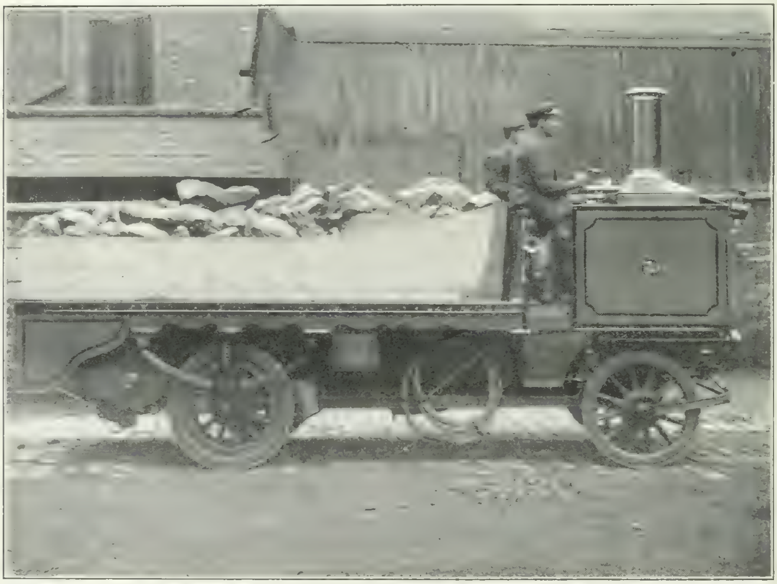
THORNYCROFT LONG FRAME LURRY.

motive type, 24 tubes, 1¾ inch diameter; total heating surface, 53 square feet; fuel, coke; working pressure, 150 pounds per square inch; engine, horizontal compound; cylinders, 4 inch and 6½ inch diameter by 8 inch stroke, with single eccentric reversing gear; develops 14 brake horse power at 250 revolutions per minute; transmission, by cast-steel gearing and differential gear; speeds 2½ and 5 miles an hour; wheels, entirely of steel, tyres made separate, allowing of renewal when necessary. Brakes, one on main driving wheel, one on the lurry wheels and reversing of engine. Capacity of water tanks, 108 gallons.

The "Bayley"; builders, Bayley, Ld., Newington Causeway, London, S. E.:

Description.—Carries 3 tons; generator in front; motor in casing forming driver's seat; steering, Ackermann's, controlled by hand wheel and spur gearing; platform, 9 feet 9½ inches by 6 feet 2½ inches; area, 61 square feet; boiler, modified de Dion et Bouton type; fuel, coke; engine, vertical compound, inverted; cylinders, 4 inch and 7 inch diameter by 5 inch stroke; stated to develop 22 brake horse power at 500 revolutions per minute; is completely enclosed in oil-tight and dust-proof casing; transmission, bevel and spur gearing are used to transmit the power. The after-end of the crank-shaft is prolonged and carries two spur wheels, which drive a lower longitudinal shaft, each gear being put into engagement by a sliding clutch. This lower shaft is coupled by a universal joint to the main longitudinal transmission shaft, which is geared through bevel wheels to the compensating motion upon the transverse shafts, which in turn drive the rear road wheels by pinions engaging internal spur-rings. All the transmission gears and shafts are encased in cast-iron grease boxes. Ratios of gearing, 8.4 and 13.7 to 1. The wheels, which are dished, are of the military type. Brakes, double-purchase wood-block brake on the crank-shaft, actuated by foot-pedal, band-brakes on pulleys, outside spur-ring on driving wheels, worked by hand lever; these in addition to reversing the engine. Capacity of water tanks, 82 gallons; of bunkers, 3 hundredweight of coke.

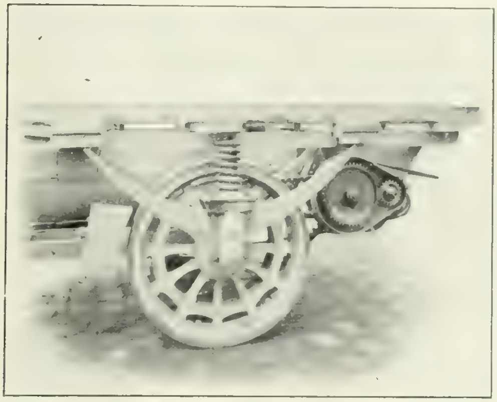
"Clarkson Capel"; makers, Clarkson & Capel Steam-Car Syndicate, Ld., London.



STEAM LURRY WITH COAL BODY FOR 4½ TONS.

Length over all, 16 ft. 6 in.; length of platform, 11 ft. 6 in.; width, 6 ft. 5 in.; height from ground, 3 ft. 8 in.; water capacity, 140 gals. = 20 miles; fuel bunkers, 6 cwt. = 40 to 50 miles; fuel used, Welsh coal or coke. By Simpson & Bodman, Manchester.

Description.—Carries 3 tons; generator and motor in cab; steering, Ackermann's, controlled by hand wheel and worm gearing, with roller bearings fitted to the short axles; platform, 11 feet by 6 feet 4 inches; area for goods, 70 square feet; boiler, fire-engine type, with small inclined steel cross-tubes (water tubes); working pressure, 200 pounds per square inch; test pressure, 350 pounds per square inch; fed by pump driven from engine; feed controlled by automatic reciprocating float-gear; fuel, petroleum; burner, "Clarkson Capel," which is of the

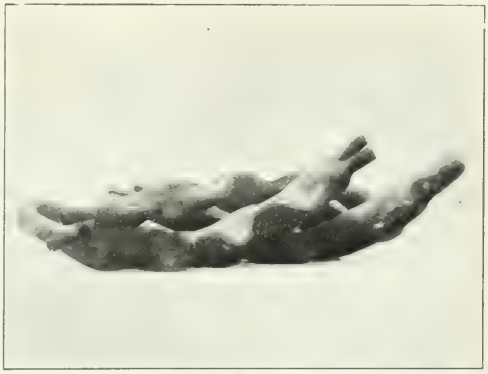


REAR END OF SIMPSON & BODMAN LURRY.

true Bunsen type; engine, vertical, compound, reversing; cylinders, 2¾ and 6 inch diameter by 4 inch stroke, enclosed in oil-tight casing; stated to develop 14 brake horse power at 600 revolutions per minute; piston valves used in both cylinders; cylinders not lubricated; atmospheric condenser is fitted on roof of cab; propelling fan used for cooling purposes; transmission, the engine shaft carries a two-speed gear of novel construction, of which the higher is put into engagement by an expanding clutch; final drive from compensating gear to road wheels by Renold's chain; ratio of gearing, 12 and 36 to 1; brakes, band-brake on engine shaft, steam brake on driving tyres; wheels have phosphor-bronze hubs, being of the artillery type, with reservoirs for lubrication; capacity of water tank, 49 gallons, and of oil-tank, 30 gallons.

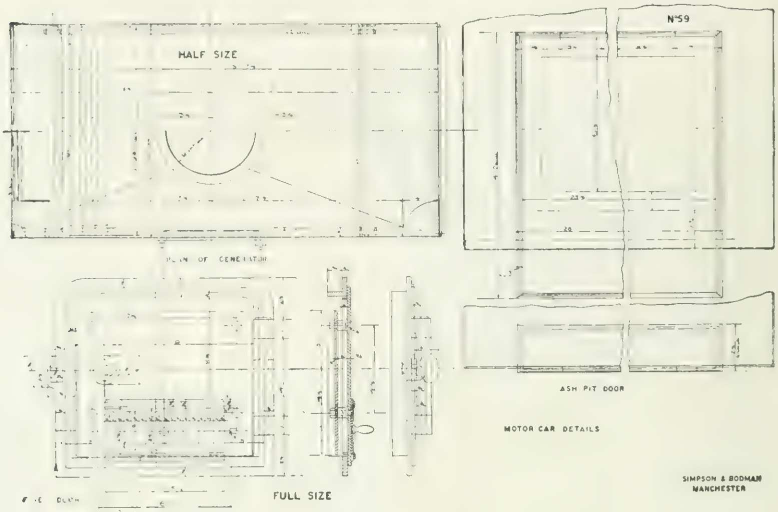
"Simpson & Bodman"; makers, Simpson & Bodman, Cornbrook, Manchester:

Description.—Carries 5 tons; generator in front; steering, the steering arms outside of wheels, instead of inside as usual; platform, 17 feet 4 inches by 6 feet 5½ inches; area for goods, 98 square feet; generator, flash type, built up of Row's tubes, connected by return bends and Haythorne's joints; fuel, coke; working pressure, 100 pounds



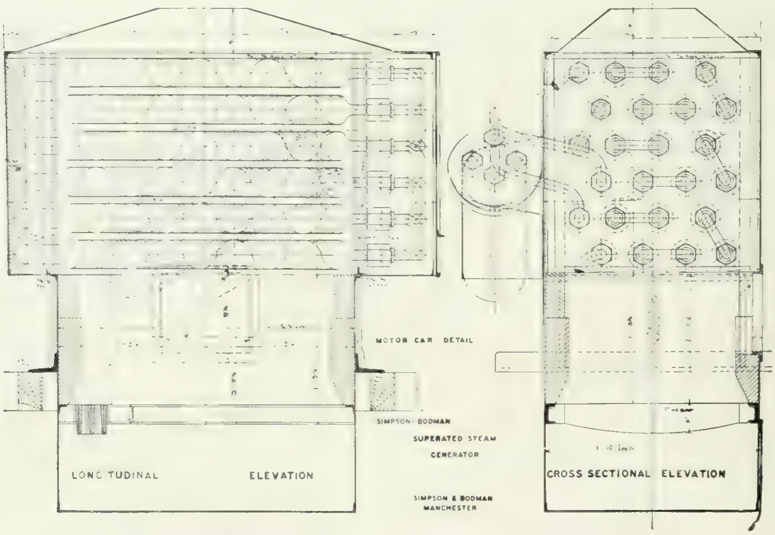
DAMAGED BOILER TUBES, AFTERWARDS STRAIGHTENED AND REPLACED AT SMALL COST, AND NOW AT WORK.

The lurry, of Simpson & Bodman's make, jibbed badly at the foot of a steep hill during a snowstorm. For 5 hours the fire was kept up vigorously, and through inattention these tubes sagged down as shown. They are, however, practically uninjured, weighing now 176½ lbs. as against 180½ lbs. when new.

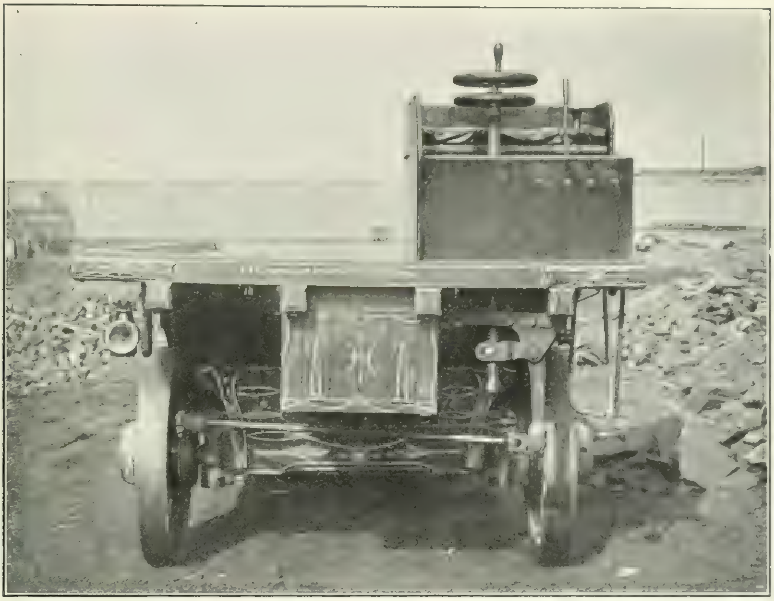


PLAN OF GENERATOR AND DETAILS, SIMPSON & BODMAN MOTOR WAGGON.

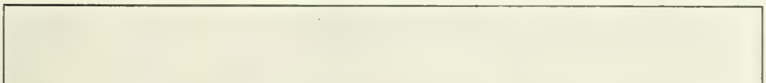
per square inch; engines, three-cylinder single-acting, one on each side at rear of vehicle, with simple reversing gear; transmission, from each engine to each driving wheel by means of spur gearing and chains; wheels, exceptionally strong, of wood and metal; brakes, one "toggle" tyre brake and reverse of engine; capacity of water tank, 100 gallons; of coal bunkers, 6 hundredweight; differential or compensat-



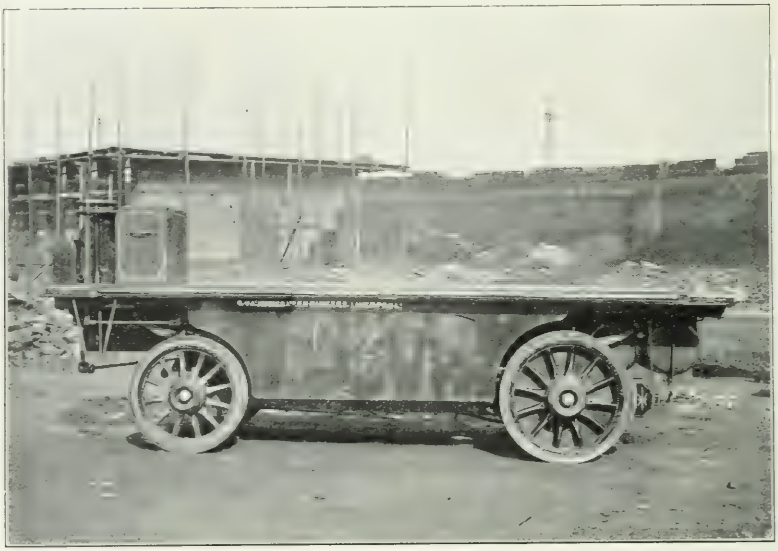
SIMPSON & BODMAN STEAM GENERATOR ELEVATION.



10-TON STEAM WAGGON. FRONT VIEW.
C. & A. Musker, Liverpool.



BACK VIEW OF SIMPSON & BODMAN LURRY.



SIDE VIEW OF 10-TON STEAM MOTOR WAGGON.

By C. & A. Musker, Liverpool.

ing gear is not employed. This is the simplest and most commercially-practical vehicle employing a flash-type boiler.

The "Musker"; makers, Messrs. Musker, Liverpool, being as yet only in its experimental stage, no reliable data of this vehicle are at present obtainable. Its special features are, however, an efficient liquid-fuel burner, combined with a flash-type boiler built up of three cylindrical coils of strong steel tubes, the flame being made to circulate in the annular space between them. The waste products of combustion require no chimney for their escape; the burner and boiler are fed automatically by a separate engine, which also drives a fan for the supply of necessary blast to burner. It is claimed that this motor vehicle is absolutely automatic in its action. The generator and all mechanism being below the platform, a much larger loading area is secured than on any other vehicle.

COMMERCIAL REQUIREMENTS OF WATER-POWER GOVERNING.

By Elmer F. Cassel.

WATER power always has been, and probably always will be, the one great and inexhaustible source of power for the use of mankind. To all intents and purposes water power is perpetual motion. Its continuous use exhausts none of the resources of nature. It is abundant beyond any conceivable demands which may be made upon it. The total amount of power used in the United States alone, water, steam and every other kind, is approximately 4,000,000 horse power. The total available water power of the rivers and streams of the United States has been estimated at 200,000,000 horse power. Italy, without any coal supply, has 5,000,000 horse power of water available. Canada's water powers rival those of the United States, Norway and Sweden can furnish over 50,000,000 horse power, Switzerland, Austria, Germany, France, India, Japan, Australia—all contain almost unlimited supplies of power.

Boundless as is this supply, it is only in recent years that its systematic development has taken place to any great extent. Especially in high-head power is this the case. Notwithstanding the fact that water is the cheapest known source of power, that its use and economy have been known for ages, and that it gives the most compact and convenient installation that can be devised—it was not until modern commercial demands made its more extended use imperative that any improvements in machinery for its utilization have appeared.

With such a source of power, having every apparent economic advantage in its favor, it is evident that its use must be hampered in some way; else it would to-day be much more extensive than it is. *It is a self-evident proposition that the cheapest known source of power will be used in every case if it is feasible to do so.*

The one great (and practically the only), drawback to the use of water power has been the inability to control it. In high-head power this difficulty is exceptionally great. Up to last year the problem of governing high-head water remained unsolved. Some engineers have gone so far in their statements as to say that the problem contained difficulties perhaps impossible to overcome. I am perfectly aware that several governing devices are offered and are in use, in many cases with considerable success, but the fact remains that the use of high-head water at present is practically confined to plants where the variation in load is slight, where variations in speed are of no consequence, or where the expense of installation is no object.

The absolute reliability of the steam engine under all conditions has made it pre-eminently the great source of power the world over. The purchaser of a steam engine buys a machine that is entirely self-contained and absolutely reliable under all conditions of load. Whenever water-power plants can be put in with absolute certainty as to results, as is now the case with the steam engine, the use of water power will be enormously increased. Thousands of water-power plants are in use to-day, not because they are satisfactory, but because they are economical. The water wheel that is successful under all conditions must be as self-contained as the steam engine and as reliable. When this is accomplished it can be said that the problem of water-power governing has been solved. The field for large water wheels is comparatively limited, while the field for small water wheels is almost unlimited. The small purchaser of water wheels expects his water-power plant to be not only reliable, but comparatively inexpensive. He expects his power plant to take care of itself, for the reason that supervision is one of the items of expense he plans to do away with. He knows nothing of the various theories of governors, and if his water-wheel governor gets out of adjustment there is nothing he can do to make his plant continue running at all except to take out the governor entirely and govern his water wheel by hand.

A study of the modern practice of water-wheel governing discloses the fact that present practice is, in the great majority of cases, an attempt to accomplish the impossible. The first attempts in the line of governing water wheels were, very naturally, suggested by the practice of governing steam engines—that is, by arranging to vary the supply of water delivered to the wheel. Under the low heads in use in earlier times the difficulty of cutting off the water supply sufficiently quickly to perform the act of governing was great, and with the use of modern high heads this difficulty has been very largely increased. The inertia of a column of water moving rapidly through a long pipe line is enormous, and any attempt to shut off this water suddenly will result in the ultimate destruction of the pipe line. This fact has been stated and fully recognized by every engineer who appears of record on the subject, some of them intimating that it is probably a condition that cannot be overcome. Nevertheless the efforts of a large majority of engineers and inventors have been turned in that direction, and many of them to-day are still working on the attempt to accomplish the impossible. In the cases of large installations, where expense has been no object, some success has been achieved. This has been done by means of stand pipes to which the flow of water is diverted when shut off from the wheel, relief valves being used in addition in some cases. In this form of governing any form of centrifugal governor can be employed, its sole purpose being to throw in or out of action the mechanism necessary to operate the valves.

One idea which seems to have determined the desirability of controlling a water wheel by regulating the supply of water seems to have been that of conserving the water itself. As a common-sense proposition the conclusion must be arrived at that the successfully governed water wheel must be governed entirely independently of the flow of water. It is always good mechanics to avoid that which is difficult to overcome. The flow to a water wheel forms no factor in the problem of successful governing, although it does become an object of consideration in some cases, in the conservation of the water supply. In nine cases out of ten, however, among the small but numerous users of water wheels, it makes no difference whether the water is running out of the nozzle or going to waste over the penstock.

Another class of governor which has attained some degree of success is that class which acknowledges the above proposition and governs the power wheel by diverting the nozzle, or stream, away from the wheel. This may be called the second stage of water-wheel governing. At first thought, it might seem that close regulation by this means would be a simple and inexpensive arrangement. The underlying fault in this class of governors is the same as one of the faults in the first class of governors.

As it was pointed out in discussing the first class, a centrifugal governor is used to put in or out of action the mechanism for operating the gates, relief valves, etc.; so, in the second class of governors, a centrifugal governor is used to throw in or out of action the mechanism to raise or lower the nozzle. Obviously, it is impracticable to arrange a centrifugal governor which would have in itself the inherent power to operate a deflecting nozzle directly. In the steam engine the position of the cut-off valves is controlled by direct connection with the weights of the centrifugal governor used, and as a consequence the revolutions of the engine, while they increase slightly with a decrease in load, are constant and invariable at any given condition of load. With the water wheel, however, under both of the forms of governing cited, the condition is entirely different. An increase in speed in the centrifugal governor used throws into action the mechanism necessary to close the valve or deflect the nozzle. As a consequence, this mechanism is not thrown out of action until the speed of the centrifugal governor itself is reduced sufficiently. This action requires time, and while the centrifugal governor has acted promptly, the time occupied by it in throwing out of action the mechanism used to move the valve, or deflect the nozzle, has permitted the valve or nozzle to be moved further than was required to reduce to the proper point the power applied to the wheel. The consequence is that by the time the governing action has occurred there is not enough water reaching the wheel to keep it up to speed. This causes the slowing down of the centrifugal governor below normal speed, thereby throwing into action the mechanism for opening the water valve or raising the nozzle. Before this action can be stopped the water wheel is increased in speed beyond its proper limit and the reverse action again takes place. The best that can be said of this class of governors is, that they confine the speed of the water wheel within certain limits, but do not keep the speed constant at any point within those limits.

Various attempts have been made to overcome this fault in both classes of governors. Additional governors have been devised and added, designed to arrest the action of the first governor. Balance wheels of great weight have been added to the water wheel to assist in controlling the speed of the wheel while the governor has time to act. In some cases the weight of the water wheel itself has been enormously increased. Storage batteries and other means of absorbing excess power have been suggested and used. It is not essential to discuss these latter features at all. They dodge the real question of water-wheel governing. The very best thing that can be said of such contrivances is, that they are attempts to govern the governor.

From a study of the above two forms of governing water power, there are two reasonable deductions to be arrived at, namely:

First, A properly governed water wheel must avoid entirely any shock or strain to the pipe line.

Second, A properly constructed governor must have in itself the inherent power necessary to perform the governing action.

In addition to this, there is a third fundamental requirement before a governor can be said to be commercially successful, and that is:

Third, The governor must be absolutely reliable.

There is a fourth consideration of almost as much importance commercially, although of no importance mechanically, and that is:

Fourth, It must be inexpensive.

In order to make the use of water for power as extensive as it should be—in other words, to make its use practicable in all cases where the water power exists—economy of installation and operation and certainty of results are the two prime requisites. If the economy of the use of water for power is offset by the increased cost of installation, maintenance, or operation, it is folly to contend that the problem of governing water has been solved from a commercial standpoint. If by installing water power to save labor needed to oversee machinery and keep it in operation, you still have to keep that labor to oversee and keep in repair your governing devices, the true solution of governing water has not yet been solved. If your governing device is intricate, has any liability to get out of order, requires any attention whatever—it has not solved the problem of high-head governing. I have seen governor after governor taken out and thrown away, not because they could not be made to work fairly satisfactorily, but because there was no one around at the time who could do so. It is in water power, as in everything else; the large installations attract attention, and it is at these installations, where expense for installation and for intelligent labor to keep the plant in adjustment is not considered, that water governing has achieved any success. The universal use of water power depends almost entirely upon the small users, and not upon the large. Where there is one large installation to be put in there are hundreds of smaller installations, where the variation of load is always much greater than in the larger plant, which would be put in could these small plants be governed satisfactorily.

It is upon the deductions drawn from the above lines of reasoning that I have achieved considerable success within the past year. Starting with the proposition that the flow of water in the pipe line must be left alone, and that the governor in itself must contain the inherent power necessary to perform the governing action, there remains but one line of experiment to pursue. In following this out the following facts were developed:

First, An impact wheel can be so arranged that the buckets against which the water strikes can be moved out of the line of impact, such movement requiring a very slight application of power.

Second, In the centrifugal force developed in the rotation of the wheel body itself is found the necessary power to move the buckets out of the line of impact.

The construction which best recommends itself to this principle is the division of the wheel along the center line of the buckets into two sections, so arranged that any increase in the speed, causing an increase in centrifugal force of the moveable parts of the wheel, will cause the two sections of the wheel to separate, allowing the jet of water to pass wholly or in part between the buckets, instead of impinging directly upon them. The simplicity and advantages of this construction are apparent. It obliterates entirely the numerous complications which it has been the study of engineers to overcome. The governing action is in the wheel itself, it is instantaneous, the wheel is entirely self-contained, and the speed of rotation is absolutely constant at any point. The action of the wheel is entirely automatic, nothing being required in its operation except turning on the water when starting up the plant. The wheel contains but four moving parts; there is nothing to wear out nor to adjust after the wheel leaves the factory.

A great feature of this construction is the fact that while it does away entirely with any shock to the pipe line and requires no expense whatever for safety arrangements in governing, still, where the conservation of the supply of water is an object, it permits the use of any of the various devices for slowly shutting off the head of water without danger to the pipe line.

The above radical departure from former practice in water wheel governing would not be complete without the statement that the correctness of the conclusions arrived at has been fully demonstrated by eight months' continuous use. During that time an electric plant run by this wheel has not required a dollar of expenditure for labor to operate either the water wheel or electric plant. The variation in load is often over sixty (60) per cent., instantaneously, and to use an expression of an engineer who examined the plant, "under those conditions the indicator showed less variation than is usual in steam-driven plants where the load is practically constant."

The simplicity and economy of this form of water-power plant leave nothing to be desired. In many cases it makes possible the installation of a water-power plant for the selling of water power direct, without first converting it into electricity. It makes more feasible than ever the use of water power in a field which lately has been receiving the consideration of eminent engineers, namely, that of using water for distributing power by means of a centrally located pumping plant. The cheapness of installation permits its use by even the smallest manufacturer where he has water power to use. The desirability and advantages of the use of water under high pressure for power purposes are becoming more and more recognized every day, and any invention which makes the use of this power universally available may well be classed as one of the great inventions of the age.

APPLICATIONS OF ELECTRICITY IN THE COLLIERIES OF GREAT BRITAIN.

By Sydney F. Walker.

DEALING in my preceding paper with the chief underground power applications of electricity in coal mining, I discussed rock cutting, haulage, and pumping. It remains to consider the collateral uses for lighting and signalling, the surface plant (which is less specialised in its character), and the peculiar problems attending underground transmission and distribution.

Lighting by Electricity.—Arc lights are not much employed at collieries, nor have they been since the advent of the large incandescent lamp. Those which are used are now generally of the enclosed form, in which the carbons burn in an atmosphere very largely composed of carbonic oxide gas and so do not consume so quickly as the ordinary form, the lamps only requiring to be trimmed every 100 hours or so of actual burning. The great objection to the ordinary arc lamp is the attendance required for trimming with fresh carbons daily and sometimes oftener, and also the fact that the coal dust which is so much in evidence about every colliery seriously interferes with the working of the mechanism of the lamp. This is especially felt where, as sometimes happens, the lamp is used only occasionally, and is then required quickly. Principally, then, incandescent lamps are used, varying in power from 8 candle power up to 500 candle power.

For the pit banks, sidings, yards, etc., it is usual to employ lamps of 100 candle power to 500 candle power, arranged in a fitting similar to that now often used for lighting side streets or courts in towns, consisting of a strong enamelled-iron shade, forming at once a protector and a reflector, with a well glass below, outside the ordinary lamp glass. The whole thing—shade, well glass, and lamp—is usually attached to brackets or to tubes that can be fixed on top of poles, or in any convenient position.

The smaller lamps are arranged and protected in various ways. For the inside of engine houses, offices, etc., the well-known pendant lamp with conical shade of enamelled iron or opal is used. For other

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Mr. Walker's first article on this topic appeared in THE ENGINEERING MAGAZINE for August, 1900.

places, as at pit bottoms, on main roads, other forms in which the lamp is protected are employed. The bulkhead lamp fitting used on board ship, consisting of a ring with metal back and stout concavo-convex glass, the lamp being held between them; is very useful, as it can be sunk in the brick work well out of harm's way, yet so as to obtain the full benefit of the light. Another fitting that is much used on board ship, consisting of a short, stout, metal bracket supporting a water-tight wire-guarded fitting, is also of service where space allows.

The current for the electric lamps throughout the mine is sometimes taken from the power service, in which case they are arranged in groups of three or five, according to the pressure, each group, or a number of groups, being arranged to switch in or out together. Where a 220-volt service is employed for both light and power, as at Ackton Hall colliery, lamps can be controlled individually.

The plan described, of arranging several lamps in series, has the disadvantage that it leads to waste of lamps, and also that if one of the group fails, none of the others can be used. It has the great advantage, though, that it entails fewer joints.

More frequently, however, if the lighting service is of any magnitude, it is supplied by a separate dynamo, except in the case of those lamps in pumping or coal-cutting stations which may be at some distance from the pit bottom, and so would entail a heavy additional expenditure for cable.

In my opinion, the better plan is, where possible in mining work, to keep the lighting service separate from the power service. It may often happen that light is wanted when it is required to stop the power service; and in addition the power service is necessarily subject to continual variation, leading to continual fluctuations of pressure, and the consequent winking of the light is most painful to the eyes.

There is one other method of lighting coal mines by electricity, *viz.*, by means of portable lamps. In the early days of coal mining, the only light available was that of the candle, and this is the case in Cornish mines at present. Old colliers will tell you that they can always detect the presence of gas more quickly in their working places with a candle than with the ordinary safety lamp, and that they can always clear it off in a few minutes by fanning with their coats, the candle standing on the ground meanwhile, out of harm's way, the gas collecting near the roof. But mines are very different now from what they were in the typical old collier's day. Explosions in those days, when they did take place, were only local, and did little harm, beyond burning the clothes and skin of those near. In these days, an explosion often means the loss of hundreds of lives, and the wrecking of the mine, so that though many collieries are still worked by naked lights, either candles or small oil lamps, the number is becoming less every year, the pressure of the mines inspectors being constantly directed to the adoption of safety lamps.

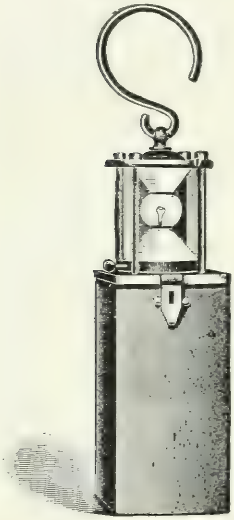
In most collieries then, the work at the face of the coal and beyond certain points in the mine is done by the aid of safety lamps. But the ordinary oil-burning safety lamp gives but a poor light, and it must not be used in any position much out of the vertical, or it goes out; and moreover, it is not a perfect safety lamp in the proper sense of the term, inasmuch as any one of the numerous forms will become red hot and explode, if it is exposed to a sufficiently powerful current of an explosive gaseous mixture for a sufficient time. Hence great efforts have been made to develop a portable electric lamp which shall take the place of the present safety lamp, at the face of the coal and in those parts of the mine where it is not considered safe to use lamps from the ordinary electric service.

Not much progress has yet been made in the matter in Great Britain, partly on account of the difficulty of the problem, partly on account of the difficulty that always attends the introduction of a new thing involving radical changes, and partly because some mining engineers will not admit the utility of a lamp, however safe it may be, which does not denote the presence of gas, as the old lamp and even candles do. The light for the face, they say, fulfills two offices —giving light and warning the miner of the presence of gas. On the continent, however, comparatively heavy electric safety lamps are in use. Notwithstanding this, I have every confidence that the next few years will see great developments in this direction. The portable electric lamp consists of a case, in which is stored sufficient electrochemical energy to furnish current for a one candle-power lamp for 10 to 12 hours or more, with a small incandescent lamp attached, the lamp being either on the top, the side, or the bottom of the case, the lamp itself being protected by a stout outer glass, similar to that used with the ordinary oil safety lamp, and usually, also, if above the case, with a metal plate and with wire guard rods.

A hook or ring for carrying the lamp completes the equipment, but in some forms of lamp there is also a switch to turn the current off when not required. The case containing the cells which form the supply of energy is also protected with an outer case, either of steel, aluminum, or wood.

The supply of energy is contained in galvanic cells, in the existing patterns in use in Great Britain now always limited to two, though on the continent more than two are used, which may be of the primary or secondary form. In the primary form a liquid is poured into the cell, zinc rods are placed in the position allotted them, the cover is screwed on, and the lamp is alight. After the run, the old liquor is thrown out, the remains of the zinc rods are replaced by new ones and fresh liquor is put in.

With the secondary form of battery, the lamp when received from the miner is placed on a charging table with other lamps, and charged by a current of electricity, either from the ordinary lighting service, or from a dynamo specially arranged for the work.



SUSSMAN'S ELECTRIC MINER'S LAMP, WITH SECONDARY BATTERY.

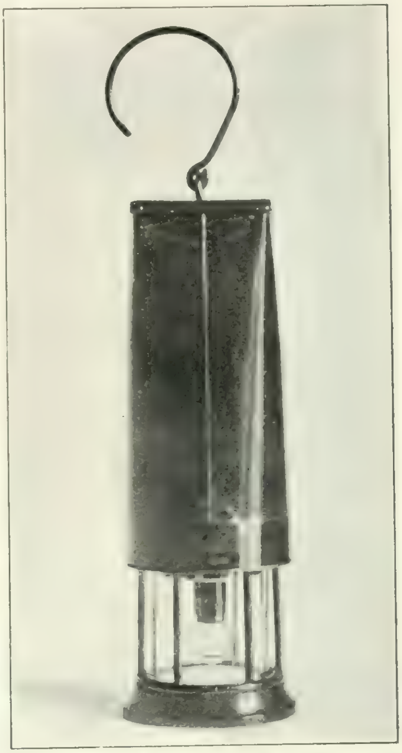
The present practice is to use the ordinary lighting service, and the lamps therefore are charged in groups, just as the lamps taken from the power service are, a small tell-tale incandescent lamp being connected in series with each group to show that current is passing through, and an adjustable resistance provided so that a smaller number may be charged in any group if desired. Both primary and secondary lamps require to have their glasses cleaned after being in use in the mine, before being reissued, but this is by no means such a long operation or so troublesome as cleaning the gauzes, glasses, etc., of the old form.

There have been many forms of secondary battery lamps brought out, but so far as I am aware only two are now before the public, *viz.*, the Sussman and the Headland. One large colliery, South Hetton, in the County of Durham, has one thousand Sussman lamps in use, in charge of their own men.

In the Headland lamp a very ingenious switching arrangement is provided. By turning the base of the apparatus in which the glow lamp itself is held, through an angle of 90°, the current is turned on or off.

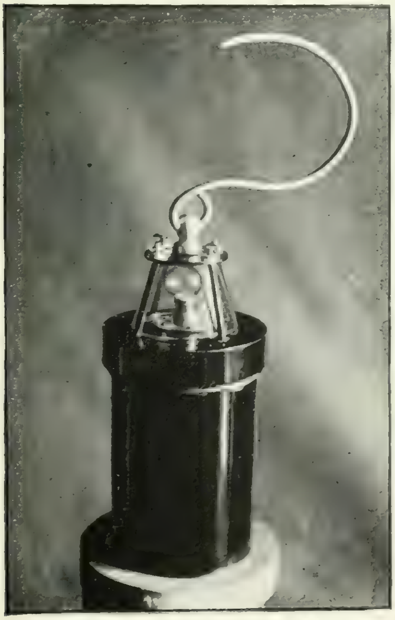
Many attempts also have been made to introduce a primary-battery lamp. So far as I am aware, the only one surviving, which has, however, not yet been placed on the market, though it has been tested in several collieries, is that shown on page 851, worked out by myself.

Lighting Locked Safety Oil Lamps and Locking and Unlocking Them by Electricity.—Electricity is used also for lighting the old form of lamp, and also for locking and unlocking them. One great danger of coal mining, where explosive gases are given off by the workings, is the willful carelessness often displayed by the miners in opening their lamps. A miner's lamp goes out, possibly owing to his having tipped it too much out of the vertical. The lamp station, where a light is kept and where he can have his lamp relighted, is some distance away, perhaps a mile. To relight his lamp, he must take his "butty's" lamp with him to see the way, so that both have to stop working for a time. The temptation is great to open the "butty's" lamp, if possible. Or, a man badly wants a smoke; he has tobacco and a pipe, and again he is strongly tempted to unlock his lamp. To prevent this, and also to save time in lighting lamps in the morning when many hundreds of men are going down the mine, a method of lighting by means either of a heated wire or of a small spark has been



HEADLAND'S ELECTRIC MINER'S LAMP.

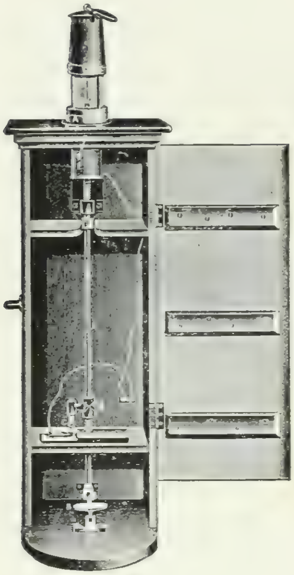
Worked by a secondary battery held within the iron case which forms the upper portion of the lamp.



WALKER'S ELECTRIC MINER'S LAMP

This lamp is worked by a primary single-fluid battery.

devised. It consists usually of a small platform with a circular hollow, into which the bottom of the lamp fits. In the hollow are two electric-contact pieces connected with a source of electricity, and on the bottom of the lamp are two other contacts which engage with those on the table, and which are in connection with the lighting apparatus over the wick. On placing a lamp in the stand, a current passes and the lamp is quickly lighted.



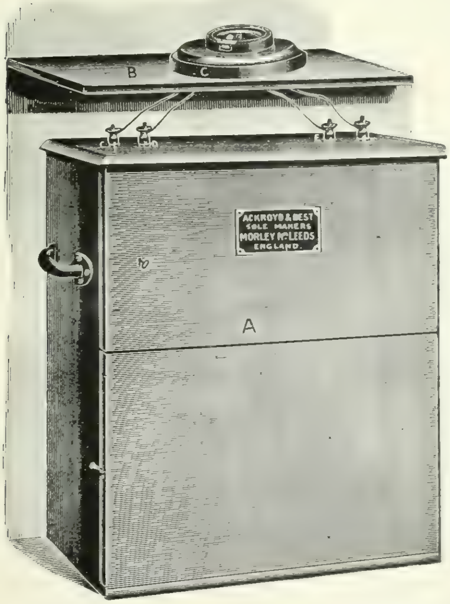
ELECTRO-MAGNETIC APPARATUS FOR UNLOCKING LOCKED SAFETY LAMPS.

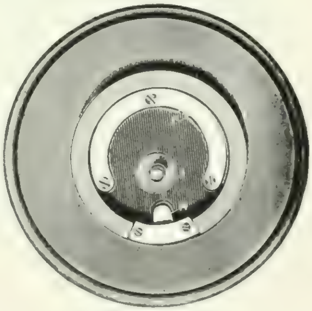
In connection with this also, in several forms of safety lamps, a magnetic lock is provided, consisting of an iron plunger forced into a recess by a strong spring, locking the two parts of the lamp together. On placing the lamp over a powerful electromagnet, the iron plunger is pulled down against the opposing force of the spring, and the lamp is unlocked, and can only be unlocked by the magnet. With all these elaborations, however, the simplicity and safety of the electric lamp is not approached.

Working the Surface Plant and Auxiliaries by Electricity.—Once an electric-power plant is installed, whether at a colliery or at any works, it is surprising how many appliances it is found convenient to work by its aid. It is only running out a pair of cables, fixing a motor, and taking a belt or rope from its pulley. Thus at Ackton Hall colliery, Pontefract, coaling screens, coal washers, traveling belts, tip hoists, pumps in out-of-the-way positions, etc., are worked from the electric-power service.

Signalling and Speaking by Electricity.—Perhaps the most useful electrical apparatus about any mine is the signalling arrangement. For haulage roads, whether the work be done by main-and-tail rope travelling from 8 to 10 miles an hour, or by endless rope at only 2 miles, more or less serious accidents are constantly taking place that would lead to serious damage, and possibly to prolonged stoppage of the mine, if the rope were not quickly stopped. The old mechanical signal, consisting of a galvanised-iron rope pulling a bell in the engine house, takes time and considerable force to operate. So a very simple system of electric signalling has been arranged for the purpose. A powerful electric bell is fixed in the engine house, near the engine man, and a battery of Le Clanché, or bichromate, cells is fixed in any convenient position near. Two naked iron wires are fixed on small insulators attached to props on the side of the engine road, the wires being only a few inches apart throughout the road but never touching. The iron wires are connected with the bell and battery, so that by pressing them together at any point, or by placing any good conductor across them, the circuit through bell and battery is completed and the bell rings. In case of an accident, the rider with the journey of trams or the attendant hooking or unhooking a tram from the endless rope has only to grasp the two wires, as he can easily do, and the engine man knows and can stop.

For long engine planes on which the endless-rope haulage system is employed, the above arrangement of signals is often extended by placing a bell, similar to that in the engine house but smaller, at each of the junctions with the secondary haulage roads and making all the bells ring simultaneously, including that in the engine house, when the two naked iron wires are pressed together. This arrangement enables help to be called to any particular junction, when required, by preconcerted signal.





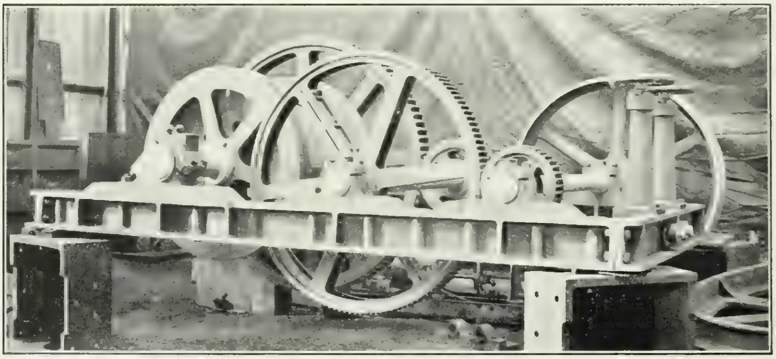
ELECTRIC APPARATUS FOR LIGHTING LOCKED SAFETY LAMPS.

It is also the practice in some mines, not those where the haulage plant is worked by electric motors, to place the hauling engine on the surface, the power being transmitted to the mine either by an endless band rope working the haulage drums near the pit bottom, or by making the whole rope travel from the engine on the bank to the end of the road.

In either of these cases, the signal may be made to ring simultaneously at the pit bottom, at the haulage drums, and in the engine house on the surface.

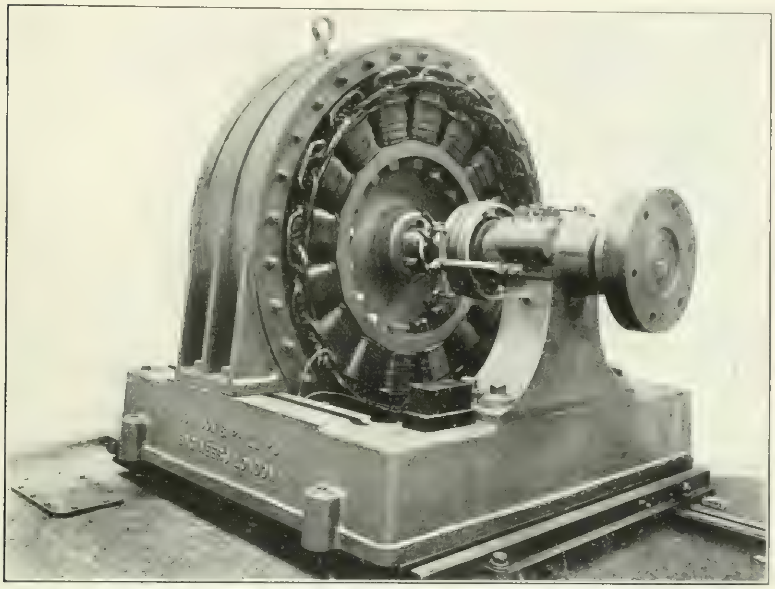
An extension of the signalling arrangements described above is the use of the same signalling wires for speaking to the engine driver from any part of the engine road. When this arrangement is made, a microphone transmitter is fixed in the engine house, with a switch enabling the engine driver to reduce the strength of the battery from that required for the signals to that required for the microphone, and at the same time to cut the bell out of circuit. The riders who go with the journeys of coal and the attendants at the junctions, as well as the overmen and others, carry in their pockets one or two small telephone receivers of the watch pattern, having clips on the ends of their connecting wires.

When anyone wishes to communicate with the engine driver, he rings a pre-arranged number of times on the signal bell, and then hooks his telephone on the wires, places it to his ear, and waits. He can hear the engine man make the necessary connections and can then speak with him. By having two receivers, one can be at the ear and the other at the mouth. In the quiet of the mine speech is remarkably clear and distinct with this arrangement. In some mines a number of telephone stations are arranged in various parts of the mine, to and from which communication can be made. Electric signals are also used for the cage in the shaft, bells being fixed at the pit bottom, the pit top, and in the engine house; and contact makers, enclosed inside



ENDLESS-ROPE HAULAGE GEAR, WITH TWO ROPE PULLEYS, READY TO BE FIXED UNDERGROUND.

Made by Ernest Scott & Mountain.



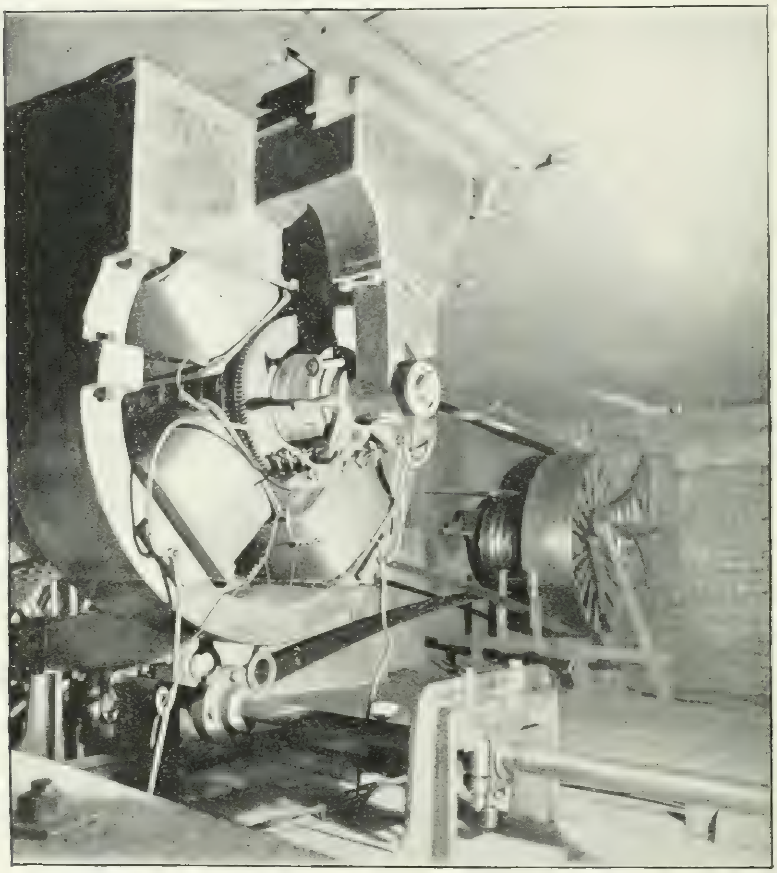
TWO-PHASE ALTERNATOR, FOR MINING POWER PLANT.

The machine shown above was built for Burmah ruby mines by Johnson & Phillips.

iron boxes, at the pit top and bottom. They are very much quicker than the old mechanical signal, but they have not found so much favour as the haulage signal, as they require more attention. There is usually a good deal of water at a coal-pit bottom, which will find its way, in spite of the most elaborate precautions, to the working contacts, and destroy the connection unless frequently examined.

Where electric shaft signals are used, the same wires are often made use of for a telephone service between the surface and one of the cabins underground, ordinary telephone apparatus being employed and brought into connection by their own switches on receipt of prearranged signals.

The Generating Plant.—As with most new developments, the use of electricity for lighting, power distribution, etc., at collieries, has grown up by degrees. The very early plant consisted of a single dynamo, sometimes driven by its own engine, sometimes by the fan or workshop engine, and placed in the fan-engine house or in the workshops at the colliery, and this was often supplemented by other isolated dynamos placed near the pit bottoms for underground work. Further, where two or more collieries were under the same ownership, separate plants were placed at each colliery, and often more than one at each.



MOTOR SUSPENDED UNDER BEAMS OF COLLIERY PIT HEAP, DRIVING SHAFTING OF COAL-WASHERY PLANT, ACKTON HALL COLLIERY.

All that is changed now. The latest practice involves one generating station, at any convenient place at the surface, as near the boilers as possible. In this are placed two or more generators, capable of dealing with all the work, lighting, and power, at the colliery. The dynamos are, in the United Kingdom, usually of continuous-current type, but on the continent of Europe and in the colonies alternating-current plant, principally polyphase, has been employed, and this last is also in use at Garswood Hall colliery, near Wigan.

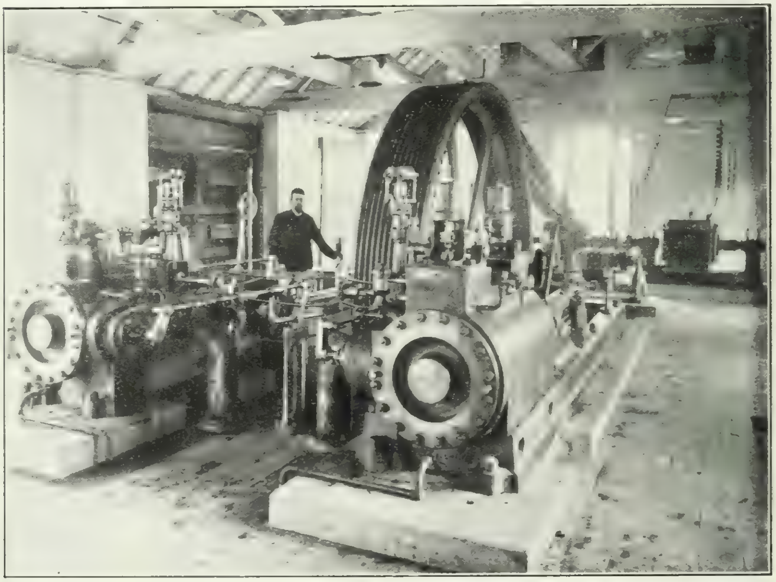
The continuous-current plants are very diverse. In some collieries only one service, that for power, at 500 volts, is provided, the lighting service being taken off the power cables. In other cases, a separate plant is provided for the power service at 500 volts, and another service at 100 volts for the lighting, each plant having its own engines driving its own dynamos. Again, another arrangement is to have the whole service at 200 or 220 volts, both lighting and power, but to have two or more dynamos and engines, arranged so that the lighting service can be supplied independently. Perhaps the best example of this latter arrangement is the installation at Ackton Hall colliery, at Pontefract. At this colliery the generating plant consists principally of the 200 horse-power Parsons turbo-generators, delivering current at 220 volts, supplemented by three or four belt-driven dynamos, with separate engines of different patterns, of 20 horse power upwards. The supplemental smaller plant was really put down first, piece by piece.

A main switchboard is fixed in the main engine house, where the Parsons turbos are working. To it are brought all the circuits for lighting and for power, and to it also are brought the main cables from all the dynamos; measuring instruments, voltmeters for each dynamo, and ampere meters for each dynamo and for each circuit, are also provided on the switchboard, and switches by means of which any circuit can be connected to or disconnected from any dynamo.

TURBO-ELECTRIC GENERATING HOUSE, ACKTON HALL COLLIERY.

It will be seen that the engineer in charge of the plant has complete control of the whole apparatus. He can see at a glance what current each dynamo is furnishing and what each circuit is taking, and can distribute the work accordingly.

At Trafalgar colliery, in the Forest of Dean, which was the very first to use electricity for power transmission, the following is the arrangement: One compound engine, capable of furnishing 260 horse power with 80 pounds' steam pressure at the stop valve, drives a separately excited dynamo, with a gramme-ring armature, capable of furnishing 150 amperes at 600 volts' pressure, when driven at a speed of 500 revolutions per minute. The driving is by means of nine ropes. Provision is made for driving a second dynamo of similar power from the same engine. A smaller dynamo is also used to furnish current for the field magnets of the large dynamo, and a portion of the lights in use about the colliery. It works at a pressure of 100 volts, and is sufficiently powerful to furnish current for the pumping plant if required. The small dynamo is driven by a separate engine, by means of belts, through a countershaft. The dynamos and engines together furnish current for an electric-haulage plant of 90 horse power and two electric pumps, besides lights at the pit bottoms, the haulage and pump houses, and the surface arrangements.



150 HORSE-POWER COMPOUND ENGINE, WITH ROPE DRIVE TO 600-VOLT 150-AMPERE DYNAMO, TRAFALGAR COLLIERY.

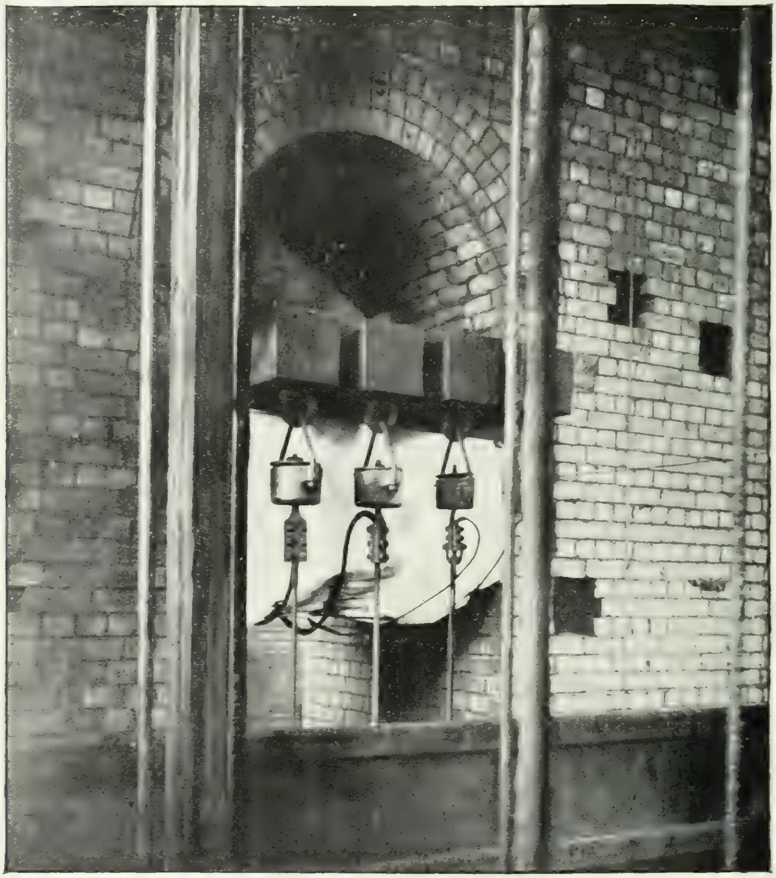
The main-engine house is in telephonic communication with the haulage-engine house, the pumps, and the end of the main haulage road.

At Garswood Hall colliery, near Wigan, Lancashire, a three-phase dynamo and compound engine furnish current for lighting the whole of the surface arrangements at the colliery, including workmen's institute and reading rooms, for lighting underground, and for driving pumps and coal cutters, the Hurd coal cutter being the one employed.

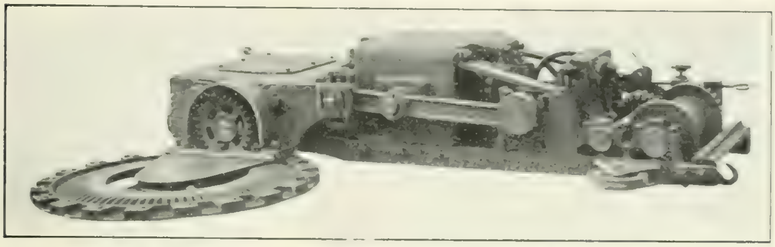
Conductors for Distributing Current.—In the early days of the use of electricity for lighting or power, many mining engineers were anxious to economise in the matter of cables, by using some of the old wire ropes that were lying about their pit-tops, and many attempts were made with only one case where genuine success was attained, so far as I am aware, and even in that case, in my opinion, results as good would have been obtained if the same money had been spent on ordinary cables. It was found, as might have been foreseen, that the old wire rope had a very much higher electrical resistance than its dimensions would have indicated, on account of the fact that few of the wires of which the rope was composed were continuous for more than a few feet at most, conduction therefore only taking place across the surface from one individual wire to another. In the one successful case, the old ropes employed were very much larger than the work in hand appeared to need.

Naked copper wires have been, and are still, in use about the surface of coal and other mines, carried on porcelain insulators, sometimes of the oil type, and where open country has to be crossed, and they can be protected from mischief, they are quite safe.

Also, in one case (at Ackton Hall colliery) Mr. Roslin Holiday, who laid out the installation, has used hard-drawn copper cables, only lightly insulated, stretched from top to bottom of the pit, to transmit the current to the pit bottom, the insulation being used merely to avoid shocks. He uses a form of insulator devised by himself, the cables being placed in a pit from which coals are not drawn. For the cables, both on the surface and underground, with the above exceptions, copper, covered with pure and vulcanised rubber, braided over all, is almost universally employed. Lead-covered cables have been tried, but in many mines the salts in the water, which is always present in the shaft, attacked the lead, which was also often damaged in fixing, with the result that the water penetrated to the insulation and the latter soon failed. The manufacture of lead-covered cables has improved very much of late years, the ability of the insulation between the conductor and the lead having been considerably increased by not subjecting it to such high temperatures in the process of manufacture. It is also possible now to have thicker envelopes of lead, and still to have the cable as a whole very flexible, even in large sizes, so that, particularly in view of the continuous rise in price of India rubber, much more may now be hoped from lead and paper than has hitherto been obtained from lead and yarn, especially as the shaft cables are getting larger and larger as the use of electricity in mines develops. The shaft cables are always the most troublesome, and their effective protection from wet and from mechanical injury presents a somewhat difficult problem. It has been attacked with fair success in two ways:

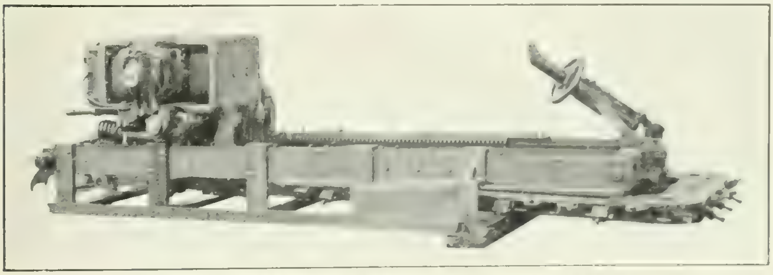


ENTRANCE TO SHAFT, ACKTON HALL COLLIERY. THE CABLES ARE SUSPENDED FROM MR. ROSLIN HOLIDAY'S SPECIAL FORM OF INSULATORS.

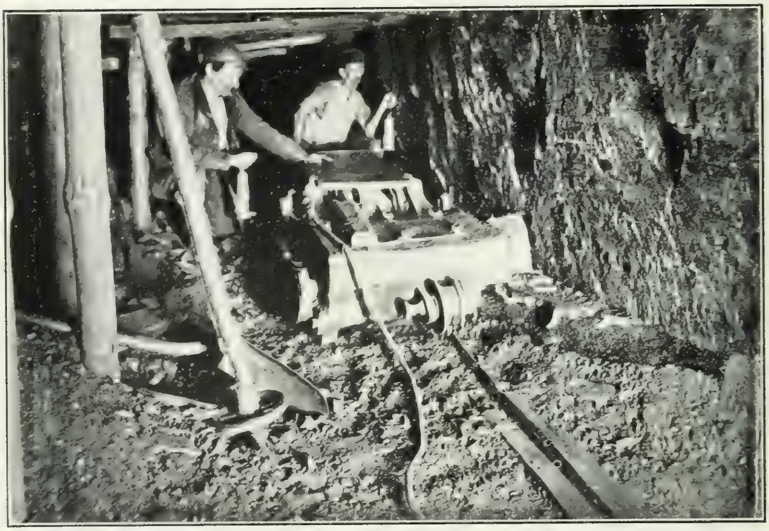


ELECTRIC-DRIVEN LONGWALL COAL-CUTTING MACHINE.
By the Jeffrey Mfg. Co.

By having a very thick covering of rubber outside the conductor, and protecting that with a further thick wrapping of jute yarn thoroughly dried and impregnated with some water-resisting (so called waterproof) substance, with again tapes or braiding, also soaked in the same substance, outside all. This has been my method of solving the problem, the object being to give the water a good deal of work to do, requiring several years—ten or thereabouts—before the insulation is broken down, and at the same time to provide a substantial cable that will resist the knocks of small pieces of falling coal, etc. The other method, which has been adopted at several collieries, is to place iron pipes in the shaft, in lengths of 50 yards or thereabouts, the pipes being large enough to accommodate easily the two cables, which are insulated and braided in the usual way. At each 50 yards is an iron junction box, fitted water-tight to the pipe, with a junction board for the cables inside. The cables are drawn into the pipes, connected at the junction boards, and the covers of the boxes put on and red-leaded. The cost of this arrangement is considerable, and the weak point is the difficulty of making a clean, dry joint in presence of the water that nearly always runs down the shaft, and of preventing the water from getting into the joint box.



ELECTRIC-DRIVEN CHAIN MACHINE FOR COAL-CUTTING.
By the Jeffrey Mfg. Co.



ELECTRIC-DRIVEN LONGWALL COAL CUTTER AT WORK IN AN ENGLISH COLLIERY.

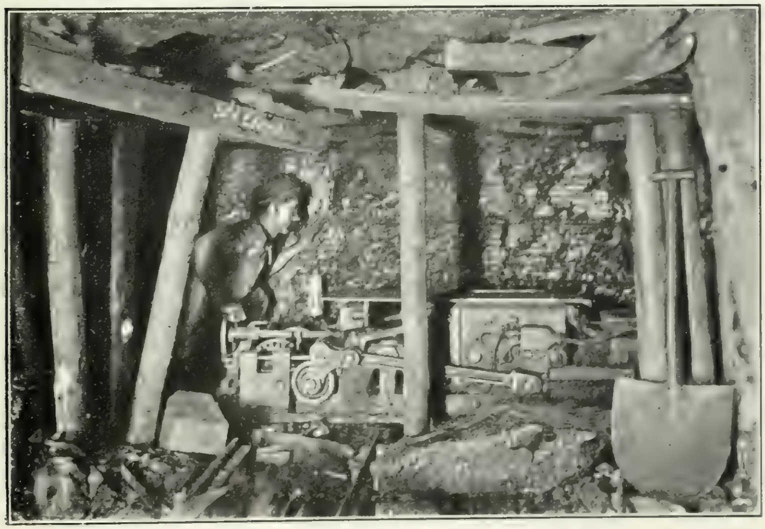
By the Jeffrey Mfg. Co.

Water in the neighbourhood of an insulated cable, or where the cable is connected to some apparatus, is always a source of trouble, for two reasons:

The water softens the insulating material, depriving it of its insulating properties, and forms a path for the leakage current to "earth," to the body of the mine, and from cable to cable. This is the trouble most feared with cables for electric-light and power services, as after leakage and the consequent deterioration of the insulation often comes sparking, the formation of arcs, and kindred troubles.

But there is also another trouble, which is not much felt with large cables, but is often a serious matter with small ones—viz., the parting of the conductor, owing to the chemical action of the water upon the copper, aided by the current. This trouble is also sometimes met with, even with large cables, at joints and at connections to apparatus. If moisture is not rigorously excluded when the joint or connection is made, which is often very difficult to accomplish, and if it is not also prevented absolutely from entering the closed joint, or between the surfaces of the connections, chemical action takes place, leading to the gradual interposition of a fine layer of comparatively highly-resisting matter, which may seriously affect the working of the lights or the motors beyond. With a number of such connections, the results may be very serious.

Two other uses of electricity may be mentioned. Electric welding has been employed to a small extent, at mines where a large generating plant exists. It is also used in the cyanide gold-recovery process, so much favoured on the Rand. Electricity finds, of course, in other mineral industries, applications which are closely related to those described in connection with coal mining. Whatever the product of the mine, the methods of working are all more or less adaptations of the methods employed in coal mines. There is always either a shaft, or a level, as it is termed, or adit, running into the mine. Wherever the ore has to be brought from a distance to the entrance of the mine there is always haulage of some kind, often small shafts or winzes, from one level to another. There is nearly always a quantity of water to be pumped out of the mine, and often from the workings. Machines are nearly always employed, worked by some form of mechanical energy, for drilling holes for the blasting charges and for cutting the ore itself. The mine and its accessories always require lighting. In all of these cases, the same practice is followed, to all intents and purposes, where it can be done economically, as with coal mines, and with the additional advantage that there are no gases to be fired in metalliferous mines, so that the electric motor, and the electric lamp, both supplied with energy by a pair of cables, often very small, that can be taken around corners, through airways, and into the most out-

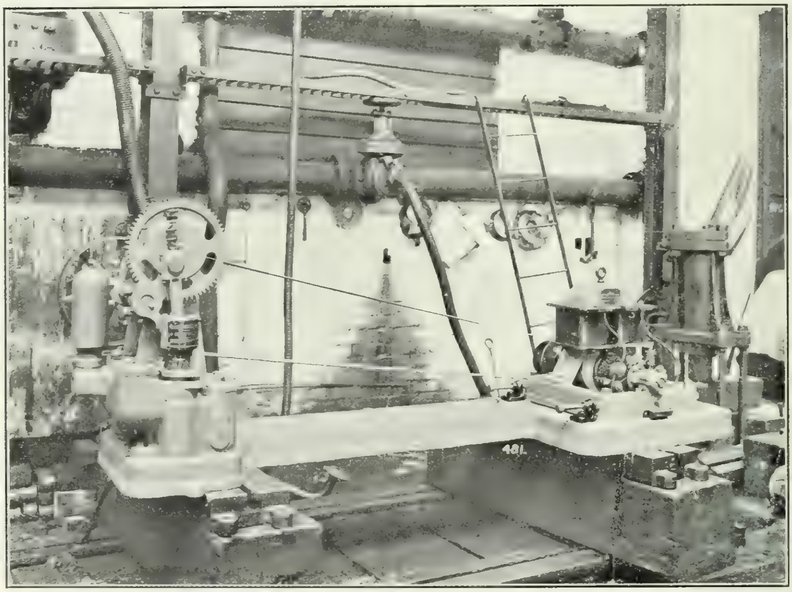


ELECTRIC-DRIVEN LONGWALL COAL CUTTER AT WORK.

A side view of the machine shown on page 862.

of-the-way situations, are especially convenient. Electricity has been largely used for lighting, drilling etc., in the ironstone mines of Great Britain, and for lighting and motive power in the iron-ore mines of Spain, but it has, up to the present, been very little adopted in the Cornish tin mines, in fact, only for lighting the surface of some of the larger mines, such as Dolcoath.

Rock drills are very largely used in Cornish mines, but they are all worked by compressed air, which, in this case, has the very decided advantage over electricity that the air emitted by the exhaust cools the atmosphere of the level and assists a "not-too-good" ventilation. Still I believe that, if other difficulties were overcome, Cornish mining engineers would find it advantageous to ventilate their deep levels by the aid of fans driven by electricity, the current for them being taken from one set of cables as in a coal mine.



SMALL ELECTRIC MINING PUMPING SET, BELT DRIVEN.
By Ernest Scott & Mountain.

The main difficulty, however, lies in the mine shaft. The shaft follows the lode, and the latter, though always tending downwards, often does so in a very erratic zig-zag fashion. In addition to this, Cornish mine shafts have usually a very large quantity of water constantly running down them, often strongly impregnated with metallic salts. Cables would, of course, follow the vagaries of the shaft easily enough, but their maintenance might be a serious item, unless the matter was very carefully gone into and full provision made for protecting them both from the water and from jagged rocks. I venture to think the matter is well worth the consideration of Cornish mining engineers, and that, properly applied, electricity would enable them to compete on more equal terms with foreign mines.

The Economy of Electricity in Mining.—And now as to the reasons for the use of electricity. In the first place, its great convenience must be noted. An electric lamp can be placed and used where no other lamp can, and practically any candle power that may be required can be had from it. An electric motor to do certain work is much lighter and handier than any other form of motor, and the cables which feed it with energy are lighter, handier, more easily got into position, and more easily maintained than the pipes required for either steam or compressed air. The electric signal and the electric telephone will do what no other apparatus will. All these are sources of economy in themselves, and the busier the mine the greater the economies effected. But apart from these considerations, the electric motor and the electric system of transmitting power is far more efficient than any other system.

Dynamos and motors are now made with a standard efficiency of over 90 per cent., a figure which is utterly beyond the reach of the steam or compressed-air motor. And though two conversions of energy are necessary, from mechanical energy to electrical energy, and back to mechanical energy, the loss involved in the two, taking the efficiency of each at only 90 per cent., works out at 19 per cent., while the loss in the cables, which must be added to this, can be as small as the mine owner will pay for; the larger the cables, the smaller the loss.

It will be understood, of course, that the figures given—a loss of only 19 per cent., or a combined efficiency of dynamo and motor of 81 per cent.—refer to the efficiency of conversion from the driven shaft of the dynamo to the driving shaft of the motor. But by the aid of electric transmission of energy, some other economies become possible, and some are automatically realised. Thus, by delivering energy from one station for all the work of the mine, or of a group of mines, considerable economies of steam are possible. Higher steam pressures, themselves a source of economy if properly utilised, can be employed, and the steam itself can be used with the full benefit of the utmost limit of expansion.

And as to the economies that are realised automatically, these are due to two important properties of the electric current and the electric motor. With steam or compressed air there are always losses in the pipes leading to the motors, due to loss of heat by the pipes, and there is a further loss at the steam or compressed-air motors from the same cause; and these losses are going on during the whole of the time that the engines may be standing, the losses from this cause being often very serious. With electric currents, so long as the cables are intact, they will always deliver the required energy to the motors, *instantly,* when called upon; they will deliver the energy exactly in proportion to the work the motors are required to perform, and there will be no loss, practically no charge of any kind, provided the cables are properly insulated, while the motors are standing.

The electric motor itself is also the most perfect governor that the skill of the engineer ever devised. It calls up and receives, instantly, the energy required to enable it to perform the work imposed upon it. When the work in front of it lessens, or ceases, instantly the call for energy is reduced in the same proportion. Farther, the electric motor gains in efficiency by the loss of heat, where the steam or compressed air motor loses. From all these causes, the use of electricity in mining is increasing, and will increase more and more as time goes on.

Mr. Walker desires to express his obligations to those who have assisted him with data and illustrations—especially to Messrs. R. S. Williamson, Frank Brain, Roslin Holiday, and W. O. Wood; to Messrs. Rosling & Appleby, John Davis & Son, The Uskside Engineering Co., Ernest Scott & Mountain, The Newton Electrical Works Co., The Allgemeine Elektricitäts Gesellschaft, The Sussman Electric Miners' Lamp Co., Johnson & Phillips, and the Nobels Explosives Co.

A SIMPLE AND PRACTICAL MEANS OF RECORDING STEAM-ENGINE PERFORMANCE.

By W. Ripper.

THE continued increase in the price of fuel and the consequent increase in the cost per unit of power produced in steam engines must inevitably lead, at no distant date, to a more frequent and more systematic examination of the daily working conditions in steam-power plants; for it is in the direction of improved conditions of ordinary daily working, rather than of improved design or construction, that we must look in the future for reduction in the cost per unit of power.

Referring at present to the engine itself, and leaving out of account the losses between the coal heap and the engine stop-valve, it may be safely stated that, before any great improvement can take place in the everyday performance of steam engines, some means must be available which will enable the steam user to know what is the actual performance of his power plant at any time, and how the performance at the moment compares with the best obtainable.

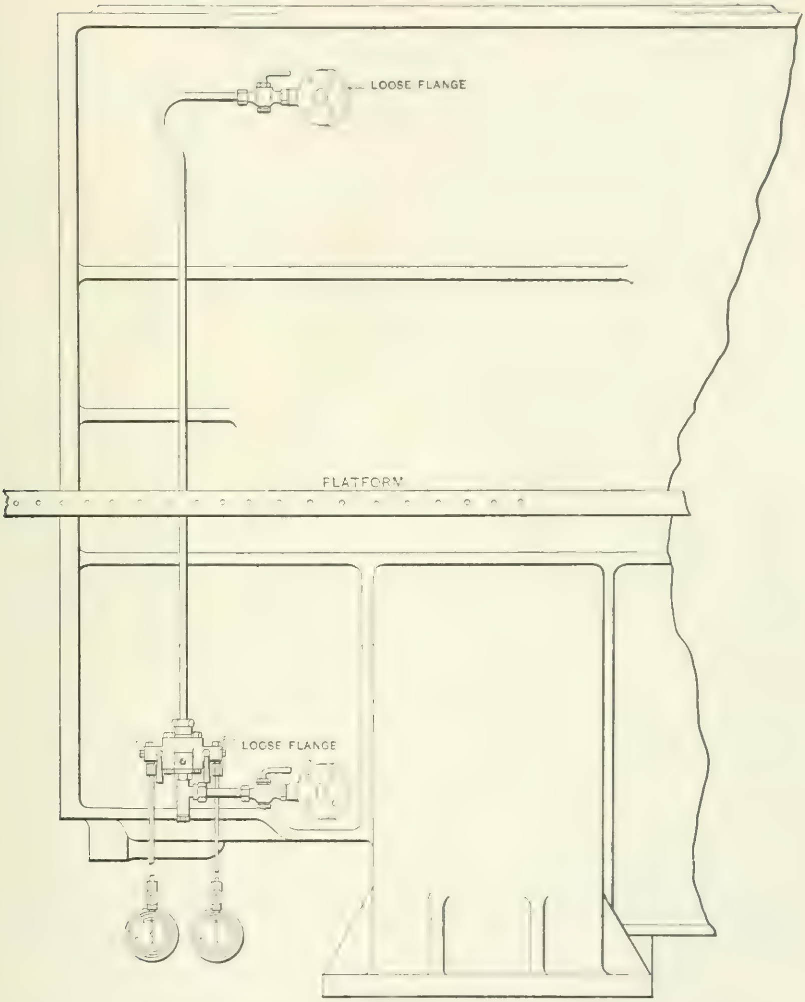
It is desirable that these results should not only be known, but that they should be systematically observed and recorded, so as to insure daily and even hourly information as to the working condition of the plant. Abnormal and costly methods of working are too often continued indefinitely, and all unnoticed, but by this means they would certainly be discovered, and steps could then be taken to avoid, so far as possible, these conditions in future.

Hitherto no such information has been available, however desirable it might be, because no simple and easily applied method of measurement has been found. The power of the engine has been obtained by the aid of the indicator, and the cost of the power in coal or steam consumption has been obtained by weighing the coal or by weighing the feed water or condensed steam. This method, however, involves the expenditure of much time and labour, to say nothing of skill and ability to make accurate measurements and calculations; and, though it is still the only method, if exact and minutely accurate results are required, it is not practicable for everyday purposes. For the close observation of the performance of the plant at any moment, and for a ready means of determining its behaviour from hour to hour, or from day to day all the year round, a simpler method is desirable.

Usually the minimum steam consumption of engines per unit of power is specified by the purchaser, and guaranteed by the maker, always with the understanding that these minimum results are obtained when the engine is worked under its best conditions; but what the cost in steam consumption per unit of power is, when the engines are worked under conditions other than the best, is probably not known to either maker or user. If those who have to pay the coal bill had a ready means of observing how great the difference may be between working a plant under good and under bad conditions, more care would certainly be taken to keep as far away from the latter as possible. Thus, to take the case of a certain high-class high-speed engine, whose performance I now have before me: Calling its steam consumption per unit of power 1.0 when working at full load, when working at one-quarter load the steam consumption per unit of power was 1.6—that is, an increase of 60 per cent. in the cost per unit; and if this latter condition of things were continued indefinitely, it is clear that there is something wrong with the relation between the power of the engine and the work it has to do, and the sooner a change is made the better for the economy and efficiency of the plant.

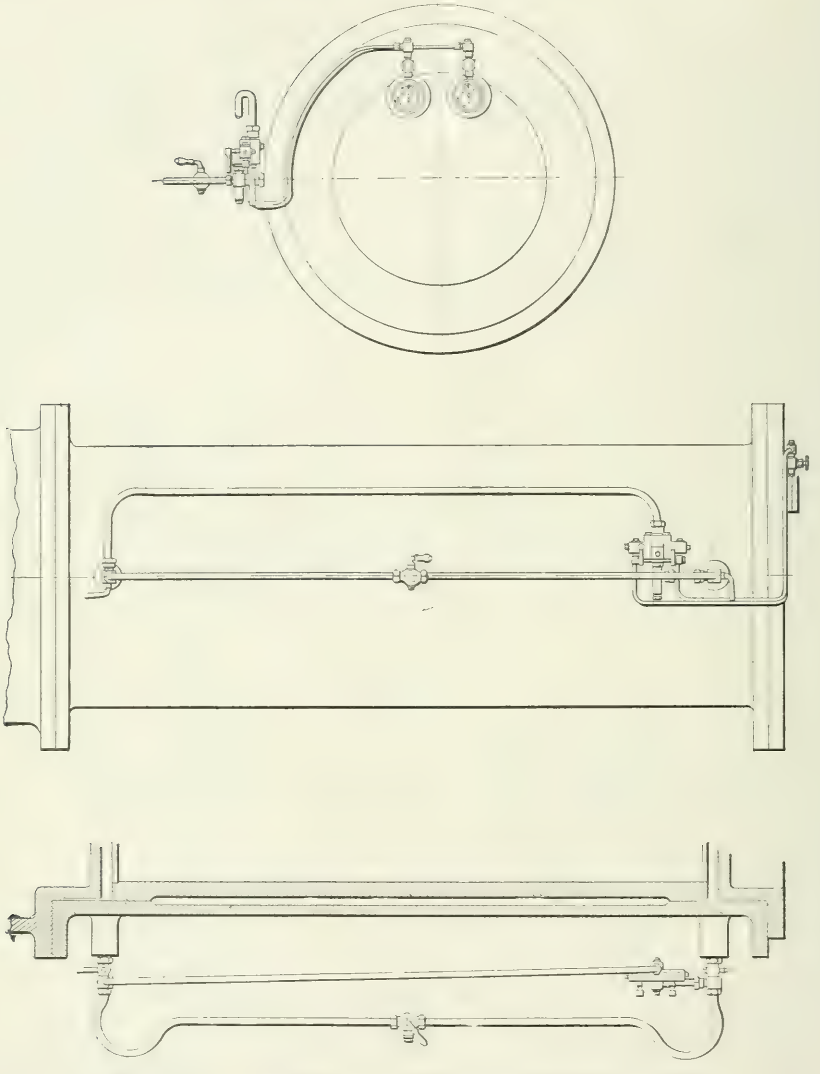
In order to obtain the information required there are two separate facts to be determined: first, the power of the engine at any moment, and second, the steam consumption of the engine at the same moment; and the problem is, how to obtain these results directly and without elaborate measurements or calculations. For this purpose I have devised an arrangement, by means of which these values may be obtained with fairly close approximation to accuracy by means of pressure-gauge readings. This apparatus, it will be seen, has its limitations, but for a large number of ordinary cases in practice it is directly applicable.

1. Power of the Engine.—To find the actual horse power we require, first, the mean effective pressure of the steam in the cylinder; and then, having counted the revolutions per minute, the horse power may be immediately obtained by calculation. But for all practical purposes, especially where the revolutions are approximately constant, it is sufficient to know the mean effective pressure alone, from which we obtain at once a knowledge of the relative power exerted by the engine. To find the mean effective pressure, the instrument illustrated on page 875, and called a "Mean-Pressure Indicator" is used. There are, it will be seen, in the first place, two pressure gauges, the first of which (A) gives the mean effect of the driving steam pressure, and the



METHOD OF ATTACHING MEAN-PRESSURE INDICATOR TO CYLINDER OF A VERTICAL ENGINE.

second (B) the mean effect of the back pressure. The difference between these two readings gives the mean effective pressure on the piston. These continuous readings on the respective gauges are obtained by the use of two valves, as shown in the figure; thus, when the steam is driving the piston downwards, it enters at the same time the valve box of the instrument, closing the ball valve to the bottom side, and communicating its pressure directly to the gauge A. At the same time the double beat valve is closed on its top side and opened at the



MEAN-PRESSURE INDICATOR ATTACHED TO A HORIZONTAL ENGINE.
The end view of the cylinder is shown in the uppermost figure.

bottom, thus placing the exhaust side of the piston in communication with gauge B. On the reversal of the pressures at the return stroke the same gauges again receive the respective forward and back pressures as before. At the recent trials of the new Cunard steamship Saxonia on the Clyde, the engines were fitted with this instrument.

Being a twin-screw ship she had two sets of quadruple expansion engines, and one instrument was fitted to each of the four cylinders of one set of engines. Indicator diagrams with ordinary indicators were also taken throughout the trial. The results obtained with this instrument, as compared with those with the ordinary indicator, are seen by the following table:

CUNARD LINE. S. S. SAXONIA. TRIAL TRIP, APRIL 25, 1900.

Time, 2.57 P. M.	H. P. Cylinder.	1st. Inter. Cylinder.	2d Inter. Cylinder.	L. P. Cylr.	Total M. E. P. Referred to L. P. Cylr.
M. E P. from Indicator Cards..	70.0	45.5	21.0	10.8	40.2
M. E. P. by Gauge Readings of Instrument......	70.0	46.5	20.8	10.5	40.0

With this instrument it is thus possible to see continuously and without the necessity of taking indicator diagrams, what is the condition of the engine, whether it is working full power, or half or quarter power, whether the conditions are constant or variable, and what the actual mean effective pressure is in each cylinder of the series in compound, triple, or quadruple-expansion engines.

To show further at a glance not only what the power is in each cylinder, but what the total is when referred to one common standard, namely, the "mean effective pressure on the low-pressure piston," I have devised a "Power Board" (see page 873), to which the mean-pressure reading from the gauges is transferred and recorded in much the same way as a billiard player's score is recorded by a billiard marker by moving a pointer along a scale. There are as many grooves with sliding buttons as there are cylinders in the engine, and the pointers then show, for each cylinder of the set, what is the mean effective pressure in the cylinder, and also (by using a double pointer to each button), what its equivalent is when referred to the low-pressure piston. By this arrangement it is easy to sum up the results on a slip of paper by the side of the scales and obtain at once the mean effective power of the engine "referred to the low-pressure piston." At the same time, also, we may see at once how the power is distributed among the various cylinders of the set. The pointers are adjusted in their respective positions after taking the mean-pressure readings from the respective gauges. The scales for the successive cylinders bear the same ratio to each other as their respective piston areas.

Sheet No.

Power Record (Ripper's Mean Pressure Indicator)

Schäffer & Budenberg,
Manchester, London & Glasgow.

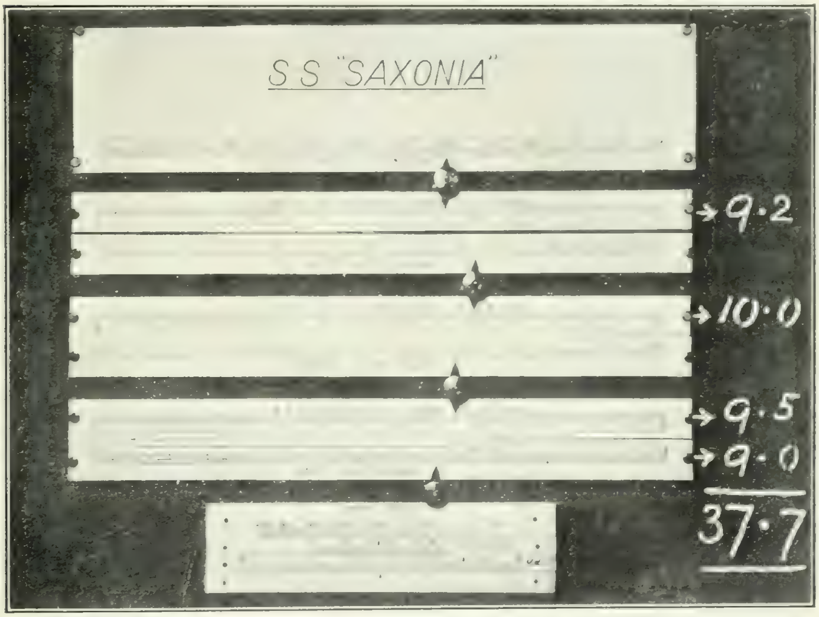
Date 190

Time	H.P. Cylinder				I. Cylinder				I. Cylinder				L.P. Cylinder			Total		* Steam Consumption Factor	Rev. per Min.	I.H.P.	Remarks
	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	+ Δ correction				

* Steam Consumption Factor per Unit of M.E.P. $= \dfrac{\text{Absolute pressure of F.P. gauge on L.P. Cylinder.}}{\text{Total M.E.P.}}$

RECORD SHEET FOR USE WITH MEAN-PRESSURE INDICATOR.

Many compound engines run continuously with the power most unevenly distributed between the cylinders, in which case such engines are like a team of horses with one horse bearing more than its own share of the load. The remedy for such a condition of things is in the first instance to be made aware of its existence, instead of, as at present is too often the case, to be going on from month to month quite in the dark as to the detailed performance of each engine of the set. When the fact is plainly to be seen continuously, as with this apparatus, it is usually an easy matter to remedy the defect and to distribute the work evenly.



POWER BOARD AS USED ON CUNARD STEAMSHIP SAXONIA.

2. Relative Weight of Steam Expended per Unit of Mean Effective Pressure.—The relative weight of steam used per stroke is obtained from the reading of a pressure gauge on the assumption that the weight of steam used by an engine (neglecting cylinder condensation), is proportional to the mean absolute pressure of the steam on the driving side of the low-pressure piston. It is, of course, more truly proportional to the absolute terminal pressure of the steam at the end of expansion in the low-pressure cylinder; but it is known that in all throttling engines, and in the low-pressure cylinders of practically all types of condensing engines, the mean absolute forward pressures

vary in the same ratio as the absolute terminal pressures.* Hence, if the readings of the forward mean-pressure gauge of the instrument on the low-pressure cylinder be taken at various loads, those readings in absolute pressure express proportionally the steam consumption of those loads.

In order to relate the steam consumed with the power of the engine, it is only necessary to divide the forward-pressure readings of the low-pressure gauge by the total mean effective pressure of the engine referred to the low-pressure piston. This result will express in terms of steam consumption the relative cost per unit of mean effective pressure exerted. Thus, taking the case of the Saxonia, the total mean effective pressure referred to the low-pressure piston during one of the trials was 44; the mean pressure by the forward gauge of the low-pressure cylinder was 15; then the factor of steam consumption per unit of mean effective pressure is 15 ÷ 44 = 0.34. In a triple-expansion engine with the total mean effective pressure referred to low-pressure piston equal to 39, and the mean pressure of the forward gauge of the low-pressure cylinder equal to 17, then the steam consumption per unit of mean effective pressure is 17 ÷ 39 = 0.436. Again, for a two-cylinder compound condensing engine with a total mean effective pressure referred to low-pressure piston equal to 35, and the mean pressure of the forward-pressure gauge of the low-pressure cylinder equal to 21.5, then 21.5 ÷ 35 = 0.6; and the relative cost per unit of mean effective power in these three types of engines is as shown in the following table:

STEAM CONSUMPTION PER UNIT OF MEAN EFFECTIVE PRESSURE.

Quadruple Expansion	Triple Expansion.	Double Expansion.
0 34	0.436	0.6

Again, referring to the two-cylinder compound condensing engine: Suppose this engine is worked at half-power, with a mean effective pressure referred to low-pressure cylinder of 18; then the reading by the forward pressure gauge of low-pressure cylinder is 12, and the steam consumption per unit of mean effective pressure is 12 ÷ 18 = 0.67. When worked at the normal load of 35 mean effective pressure, its factor of steam consumption, as we have seen from the

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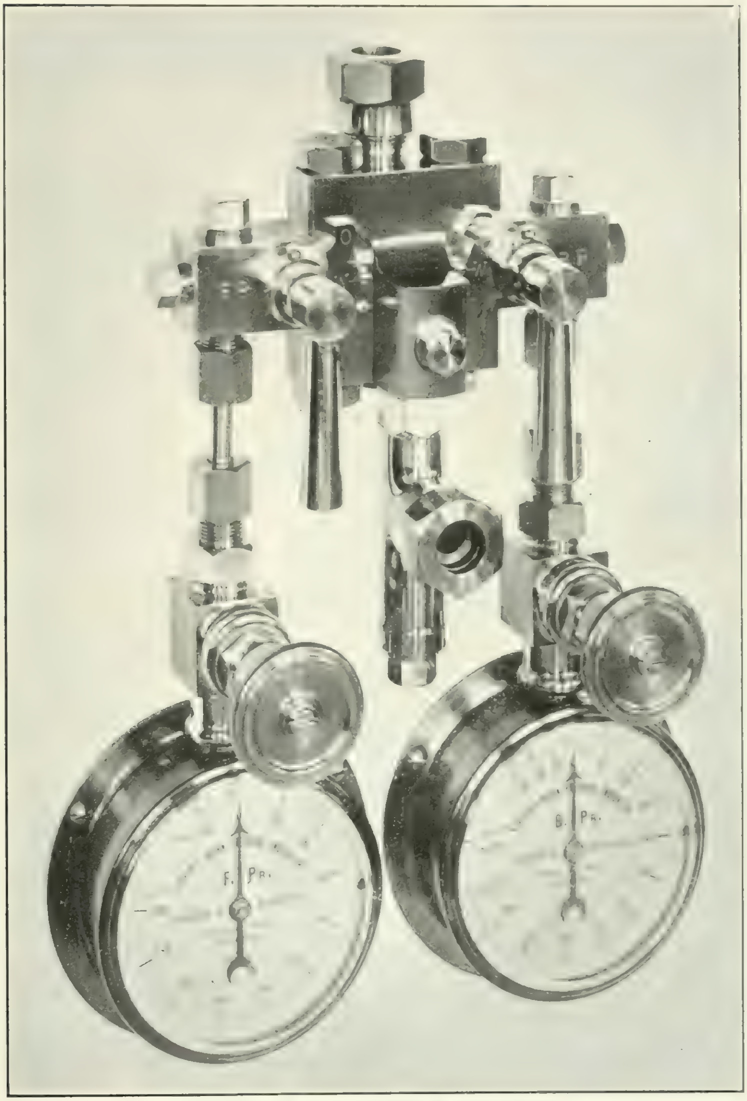
* Absolute pressure is pressure reckoned from perfect vacuum, and not from atmospheric pressure.



CONTINUOUS MEAN-PRESSURE INDICATOR.

One dial records the mean forward pressure, the other the mean back pressure, the difference giving the mean effective pressure.

table, was 0.6; so that, comparing the normal load with the lower load, the ratio of steam consumption is as 0.6 is to 0.67, or an increase of 11.67 per cent. of steam per unit of power, when working at one-half the normal power.

These examples will be sufficient to illustrate the possibility of obtaining definite information as to the performance and relative efficiency of a steam-power plant at any moment.

As to the limitations of the method here described, it is advisable, for absolutely accurate results, to standardize once for all the instrument against a good ordinary indicator, and find the relation between the two sets of results for the given engine or type of engine at light, medium, and heavy loads. For mill engines no correction is necessary for the low-pressure cylinder, but for the high-pressure cylinder with a very early cut-off and a good compression the instrument will read about 5 per cent. *high* at 0.2 cut-off, varying to 0 per cent. at 0.5 cut-off, and to 2½ per cent. *low* at 0.7 cut-off.

The engines which present the most difficulty in the use of this instrument are the locomotive and the compound non-condensing engine. Both these engines have a large compression. When working at high loads the differences are small, but when working at low loads, with early cut-off and high compression, the effect is to throw a portion of the early compression upon the steam side of the instrument, causing the forward-pressure gauge to read high and the back pressure to read low, and the engine is credited with more power than it actually exerts; but even in these cases, if the instrument be standardized for different positions of the link, and the correcting factor be once found for the full range of notches under the usual working conditions, no difficulty will be found in obtaining therefrom the true mean effective pressure by using the necessary factor of correction.

The types of engines employed on large power plants, however, usually present no difficulties, and the results obtained with them approach very closely to those obtained with a good ordinary indicator.

It is very desirable that information on the points here raised should be much more commonly known and discussed, especially among the class of practical men who are usually to be found in charge of power plants, but who are at present very much in the dark on all such matters, not because of any lack of interest or ability, but because there has hitherto been no means of obtaining such information. But now that the essential facts necessary to a knowledge of the relative efficiency of the engine at any moment can be easily determined, we may look for a considerable increase of attention to the subject, a systematic recording of results, improved condition of working, and a consequent reduction in the cost per unit of power.

THE LOCOMOTIVE EXHIBIT AT THE PARIS EXPOSITION.

By Charles Rous-Marten.

It is much to be regretted that considerations of space led the Paris exhibition authorities to banish the magnificent show of railway rolling-stock to the remote suburb of Vincennes. That the Bois de Vincennes and its island-studded lake are supremely beautiful, nobody with a particle of taste will attempt to deny. But the pity is all the greater that it should have been decided to mar that exquisite park by intruding a number of ugly buildings. And the visitor interested in locomotives feels it to be no less a grievance that he should be required to make a pilgrimage to such an out-of-the-way locality.

It is very difficult to get to Vincennes with anything like celerity. You have to allow fully an hour from the centre of Paris. Perhaps an omnibus to the Bastille and electric tram thence is the best way, unless you can tempt a cabman with double fare or more to take you thither, for if you call a cab in the street the driver simply won't take you if you say you want to go to Vincennes; you must find a cab on some regular stand—not always an easy task in exhibition time. However, when at last you do reach Vincennes and enter the plain but vast and singularly convenient and well-lighted shed in which the railway rolling-stock is displayed, you soon forget the annoyances of transit in the interest which meets you on all sides.

For it is a splendid show—there can be no two opinions about that. So great and varied a collection of fine locomotives and vehicles can hardly have been brought together ever before. And assuredly there has never been any previous exhibition which displayed so imposing an array of giants among locomotives. It is all the more to be regretted that the completion of the catalogues—so needful for the adequate study of the numerous novelties—should have been delayed for months after the opening of the exhibition, and that the means of ob-

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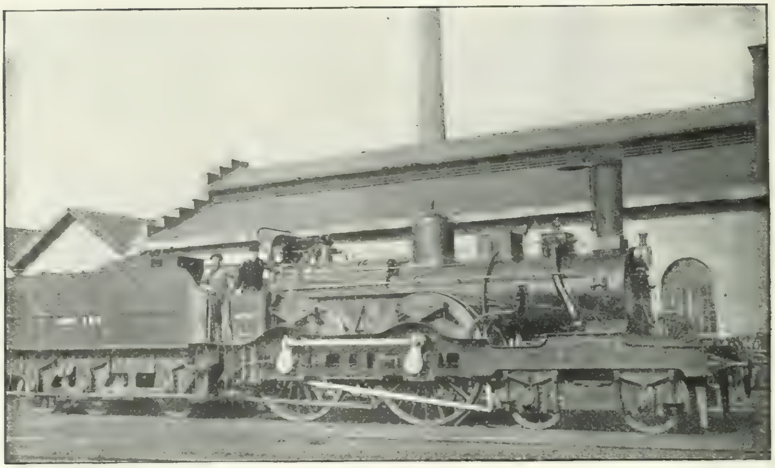
Mr. Rous-Marten's articles on British and American practice in locomotive construction, which appeared in The Engineering Magazine during the summer of 1899, were among the most widely-noticed papers ever published in these pages. In this review and the one to follow in our October number he extends the discussion over a still larger field, using the typical exhibits at the Paris Exposition as the basis of a broadly international comparison of leading tendencies in locomotive building.—The Editors.



TYPICAL FRENCH LOCOMOTIVES. NON-COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD.

"Type Outrance," predecessor of the four-cylinder compound.

taining on the spot adequate information touching the various exhibits, other than those of British or American or French origin, are lamentably deficient—or at least were so at the time of my latest visit. This has made the task of due examination very difficult, and also involves much delay.

Reviewing this section of the exhibition as a whole, I think the points which strike one most forcibly are:

(1) The enormous preponderance of the compound type of engines over the simple high-pressure type.

(2) The comparative scarcity of eccentricities in design.

(3) The immense increase in size and weight of locomotives since the last exhibition.

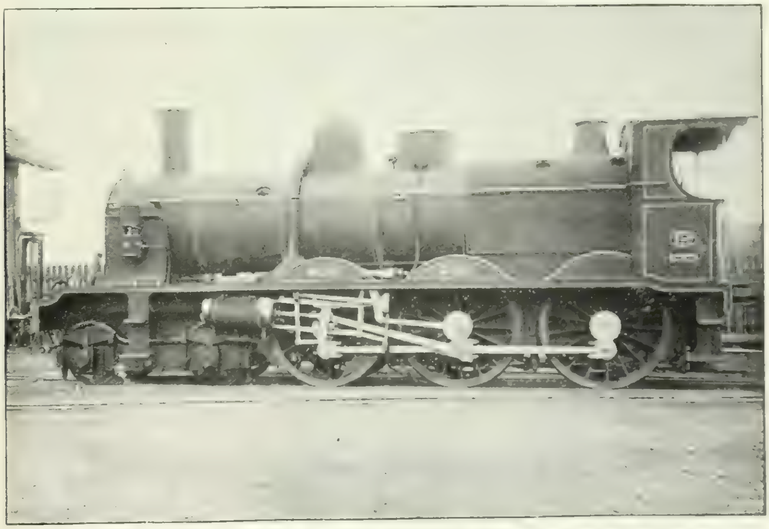
(4) The specially huge size and power of certain Russian engines.

(5) The almost universal employment of coupled wheels in express engines, and the consequent all but complete disappearance of the single-driver type.

(6) The large augmentation of heating surface and of steam pressure.

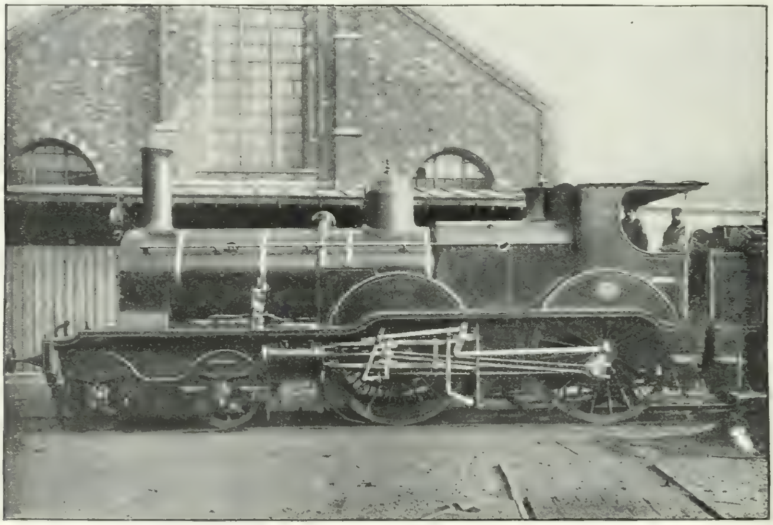
These were the points which struck me most in my general survey of the exhibition. On the whole, they represent the principle of development in locomotive practice. They tend in the direction of increased haulage power, rather than in that of any attempted addition to existing possibilities in respect of maximum speeds. It is doubtful whether any locomotive shown at Vincennes has a much higher capacity in respect of mere speed than had the Great Western engine with 8-foot single driving wheels, designed by Sir Daniel (then Mr.) Gooch and shown in the London exhibition of 1851, or than the newer 8-foot single-wheeler shown by Messrs. Neilson & Co., of Glasgow, eleven years later. At all events, if any of the most recent engines have higher speed capacity, this is due solely to the increased steam pressure employed and not to any other modification of design. The fact is that locomotive engineers are, as a rule, satisfied with the maximum speeds which have proved feasible during the past decade, and have set themselves rather the problem of hauling heavier loads at those speeds than that of accelerating the mere velocities obtainable.

This is particularly noticeable in the case of the locomotives built for service on the European continent, where maximum speeds are limited by law with extreme precision and strictness, and where the observance of those statutory limitations is enforced with stern severity. There must be no attempts to attain 90 or 100 miles an hour, as in America and Great Britain, save in special experimental trials expressly authorised and fenced round with elaborate precautions. All over Germany and Belgium, and, I believe, also in Holland and Austria-Hungary, the maximum speed is rigorously limited to 90 kilometres (or about 56 miles) per hour. I understand that a similar restriction exists on the Etat Railway of France and it also does—or did until very recently—on the French Western line. For a long time the



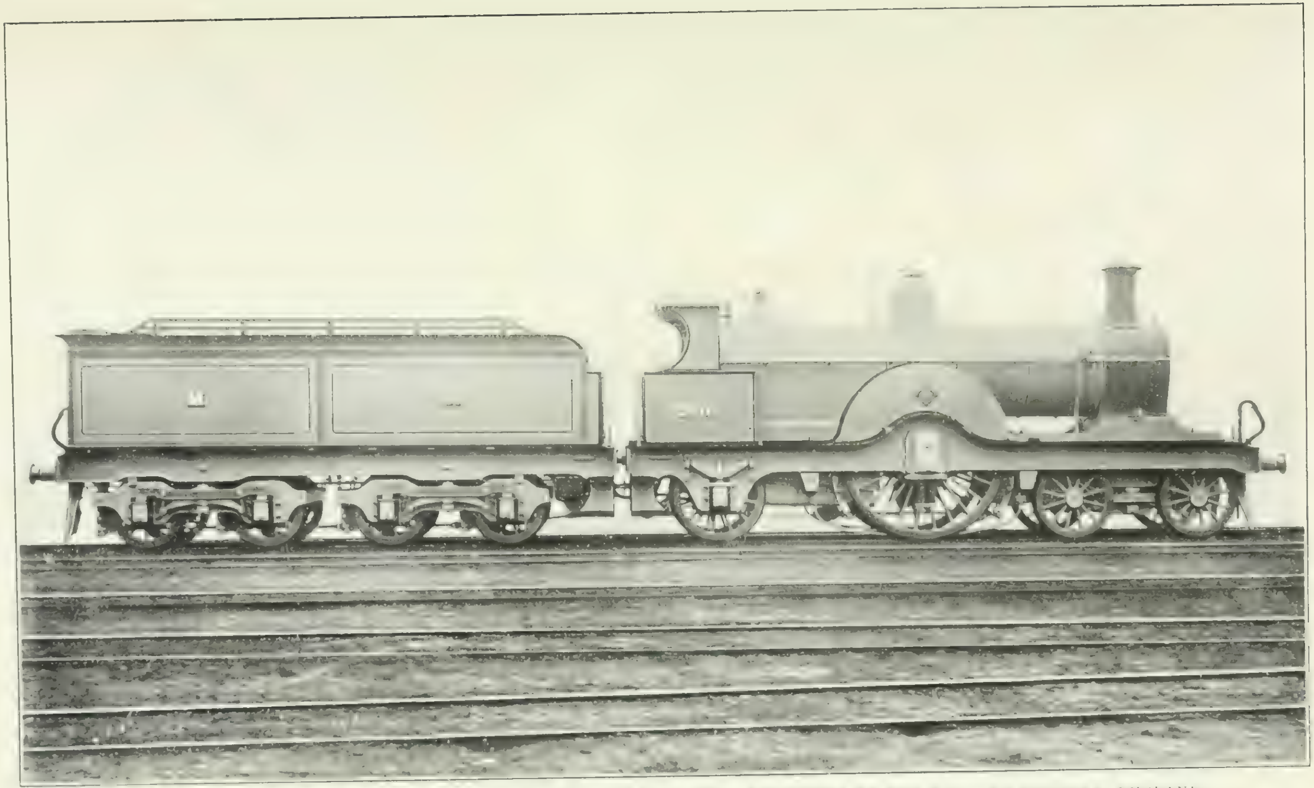
TYPICAL FRENCH LOCOMOTIVES. TEN WHEELED FOUR-CYLINDER COMPOUND LOCOMOTIVE, CHEMIN DE FER DU NORD. NEW SIX-WHEEL COUPLED TYPE.

Chemin de Fer du Nord stood alone in France in being permitted to run at 120 kilometres—74.5 miles—an hour, but this is now sanctioned also on the Orleans, Est, and Midi lines. The Orleans Railway was limited to 112½ kilometres—70 miles—an hour, up to little more than a year ago, and the Paris-Lyon-Mediteranée to 100 kilometres—62.1 miles—an hour. I believe that on the latter railway this limit has lately been extended, and on the Nord line a speed of 125 kilometres—or 77.6 miles—may be run on special occasions by direct permission. But the principle of restriction holds good over the entire European continent. The limit may be 77.6 miles an hour, as in the single exceptional case just quoted, or it may be 74.5 miles, as in those and a few other instances, or 55.8 to 62.1 miles, as on the large majority of European lines. But the limitation is always there and cannot be evaded without the risk being incurred of heavy penalties. In America and Great Britain no such restrictions exist, and the latter country accordingly presents in its exhibits the sole exception to more than one of the principles which I have indicated as generally prevalent among the locomotives shown in 1900.



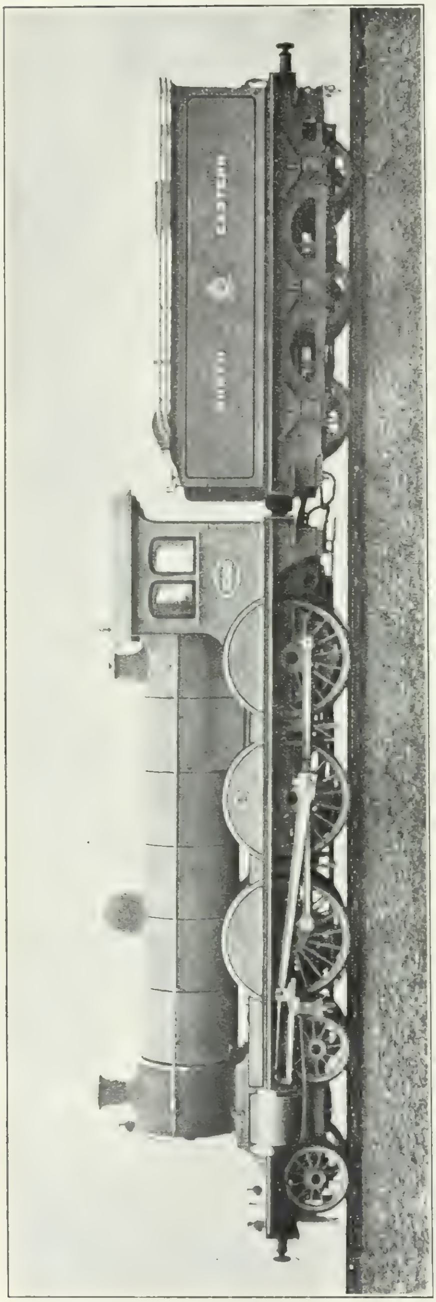
TYPICAL FRENCH LOCOMOTIVES. FOUR-CYLINDER COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD.

Indisputably the chief exception offered by England to the rule of modern locomotive practice as exemplified at Vincennes in this year, the hundredth and last of the nineteenth century, is that of the Midland exhibition engine, which is the sole instance of a single-driver engine among all that crowd of express engines present. Even



SINGLE-DRIVER EXPRESS ENGINE "PRINCESS OF WALES," NO. 2601. EXHIBITED BY THE MIDLAND RAILWAY, ENGLAND.

Designed and built at the company's works, Derby, by Mr. Samuel W. Johnson, chief mechanical engineer.



SIX-WHEEL COUPLED EXPRESS ENGINE, NO. 2006. NORTH EASTERN RAILWAY, ENGLAND.

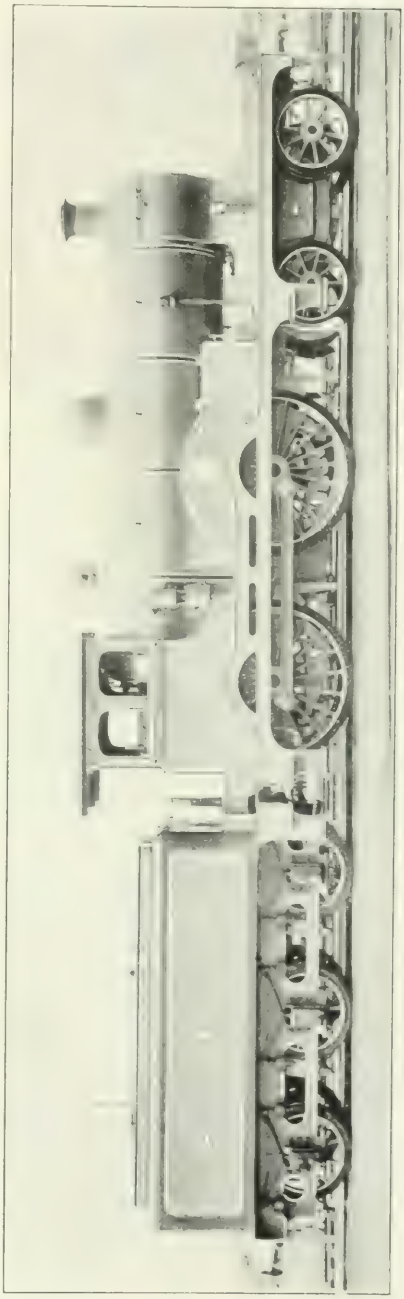
Designed and built at the company's works, Gateshead, by Mr. Wilson Worsdell, chief mechanical engineer.

among the four locomotives of purely English design, which, I regret to say, constitute the entire display in the British section, this Midland engine, "Princess of Wales," No. 2601, is the sole single-wheeler. The Great Western and London & North Western exhibits are coupled express engines, and the North Eastern is not only coupled but six-wheel-coupled as well.

Now this is in itself a fact of such important significance as concerning the present tendency and drift of modern locomotive practice, that I have selected it as the first among the characteristic principles which govern the present exhibition of locomotives. But the question is: Of *what* is the fact significant? What conclusions are we to deduce from the circumstance that only this one single-wheeler is to be found in the present exhibition?

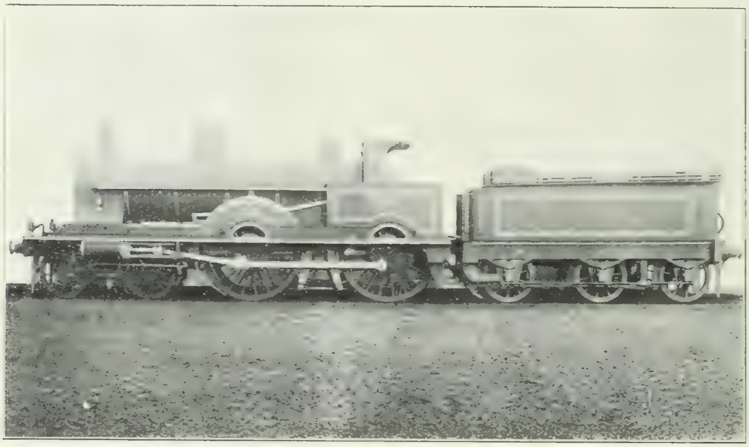
Naturally, the reply given upon impulse would be that it implies the virtual extinction of the single-driver type at no distant date. But is this so? Let us see.

It is a curious feature in this problem that the sole representative of the once-universal single-driver type for express duty is designed by an engineer—one of the most eminent in England—who for many years, in fact up to the year 1885, set his face utterly against the use of that type in any circumstances or under any conditions. While the Great Western, Great Eastern, and Great Northern Railways were turning out single-wheelers in large numbers and claiming for them distinct superiority on fast express work, Mr. Johnson continued calmly to build nothing but coupled locomotives for that same class of duty, although his trains were timed quite as fast as those worked by single-wheelers, and in some cases even faster. But all that time Mr. Johnson had not been unobservant of the excellent work eccomplished with ease and marked economy by the Great Northern and Great Western single-wheelers. So when, by the introduction of the Gresham sand-blast, slipping—that objectionable propensity of single-driver engines and their most serious drawback—was reduced to a minimum, Mr. Johnson brought out a new type of single-wheelers. which, although it has under-



FOUR-COUPLED LIQUID-FUEL-BURNING EXPRESS ENGINE, NO. 1900. GREAT EASTERN RAILWAY.
Designed and built at the company's works, Stratford, by Mr. James Holden, chief mechanical engineer.

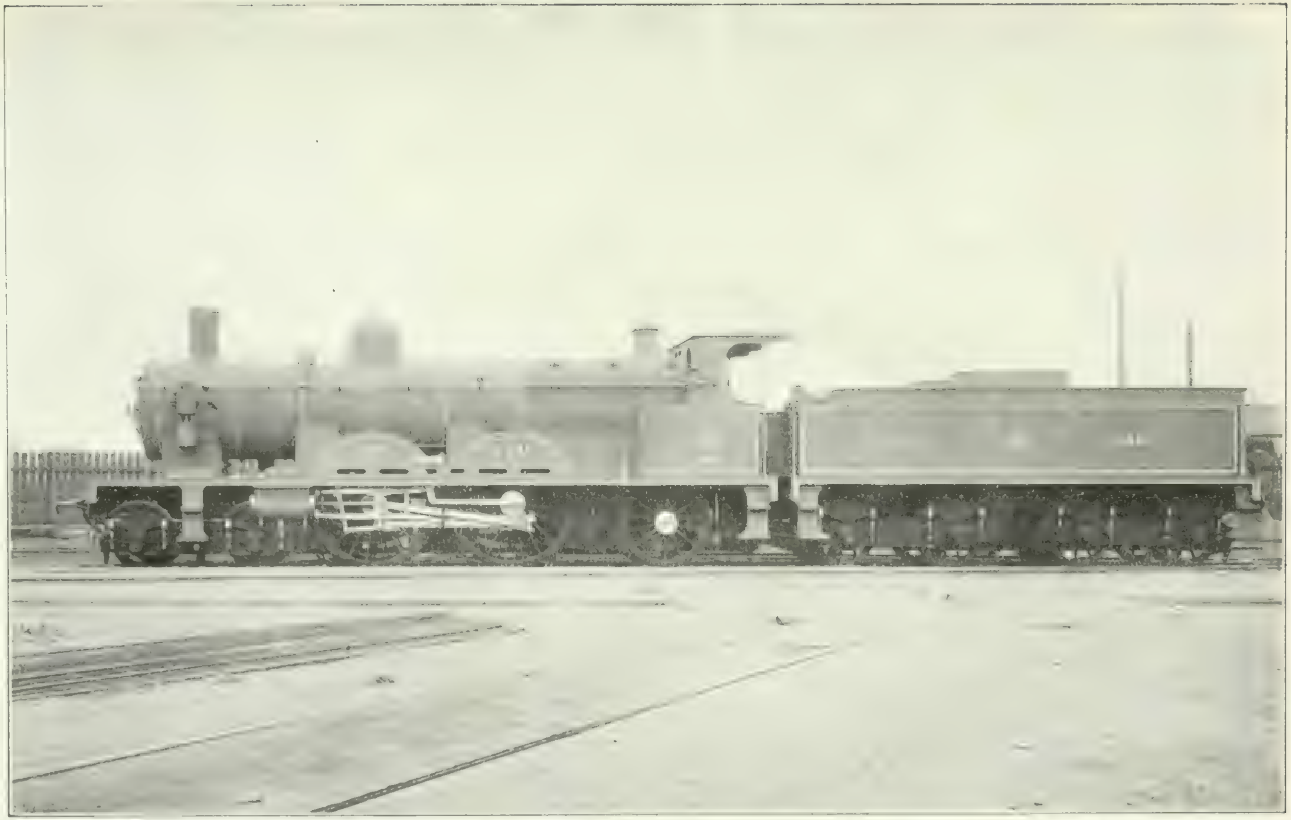
gone five successive developments, of which the latest is to be seen in the beautiful engine at Vincennes, yet remains the same in all but relatively minor details. Nos. 25-29, the earliest numbers of the now numerous class, had 18-inch cylinders, 26-inch piston-stroke, and 7 foot 4 inch single driving-wheels. No. 1853—prize winner in the Paris exhibition of 1889—and her sister-engines, had 18½-inch cylinders and 7 foot 6 inch-wheels. No. 79, etc., had 19-inch cylinders; No. 115, etc., had 19½-inch cylinders and 7 foot 9 inch-wheels, and finally No. 2601, with the same-sized cylinders and wheels, has a larger fire-box, higher steam pressure, and a double-bogie tender. But the type is the same, persistent throughout. Thus the fact that Mr. Johnson brings out in 1900 a new development of this type must at least be accepted as evidence that one of the most eminent of British locomotive engineers does not regard the single-driver type as archaic or obsolete, but, on the contrary, sees in it a potentiality of much continued usefulness if employed upon work suited to its special idiosyncrasies.



FOUR-CYLINDER COMPOUND FOUR COUPLED ENGINE "JUBILEE,' DUPLICATE OF THE ENGINE "LA FRANCE."

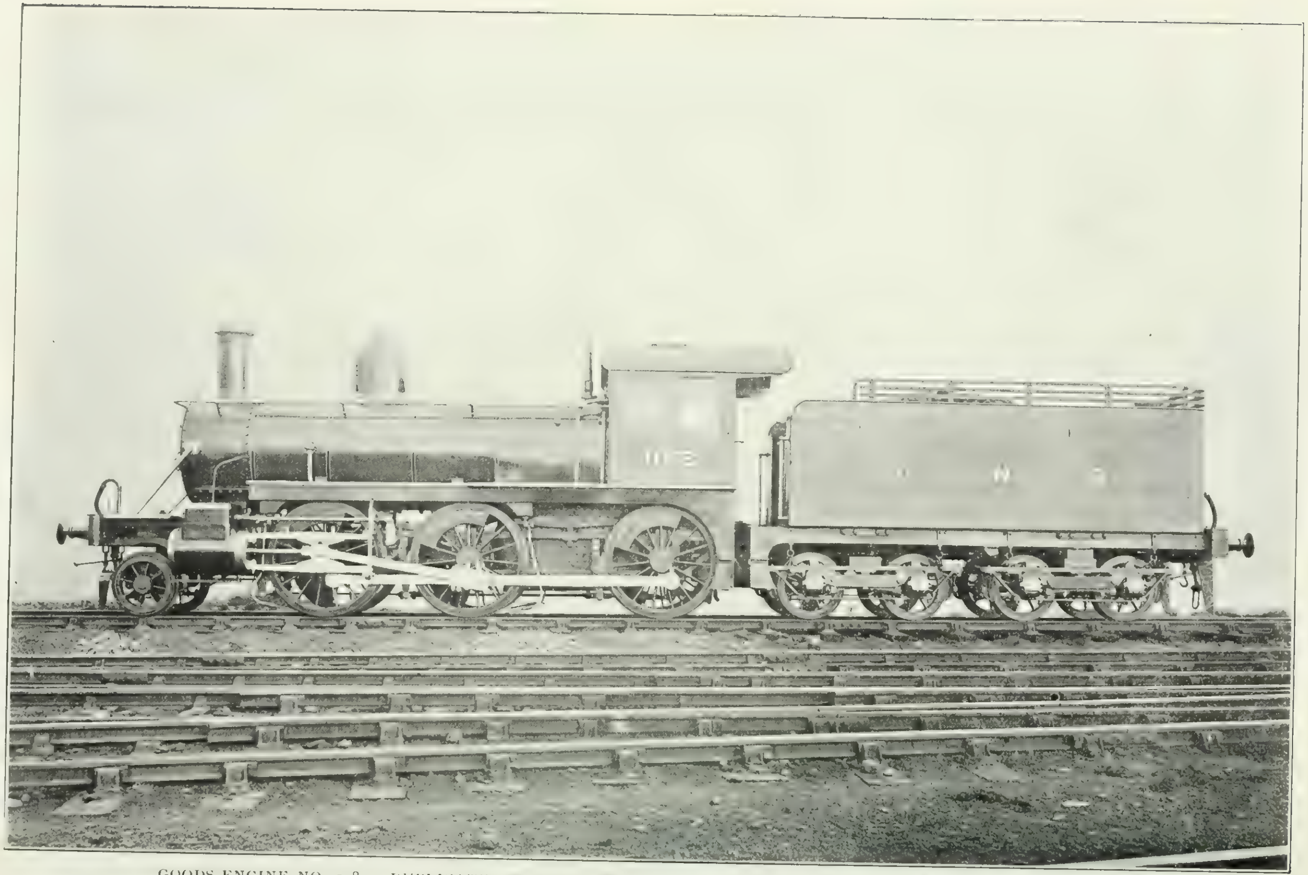
Exhibited by the London & North Western Railway, England; built at the company's works, Crewe, by Mr. F. W. Webb, chief mechanical engineer.

Nor does he stand alone in this view, if one may judge an engineer's principles by his actions, the tree by its fruits. For Mr. H. A. Ivatt, the able chief mechanical engineer of the Great Northern Railway, who, like Mr. Johnson, has built and continues to build large numbers of fine express engines with coupled wheels, has quite recently turned out two remarkably excellent specimens of express single-wheelers. So has Mr. Harry Pollitt, chief mechanical engineer



FOUR-CYLINDER COMPOUND FOUR-COUPLED EXPRESS ENGINE, NO. 2641, CHEMIN DE FER DU NORD, FRANCE. DE GLEHN COMPOUND SYSTEM

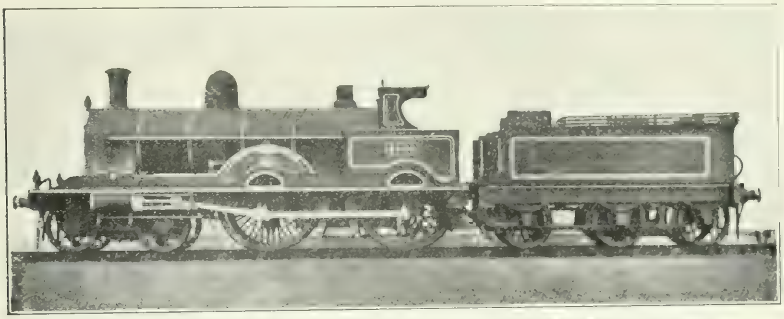
Designed by M. du Bousquet, ingénieur en chef du materiel et de la traction, and built by the Societé Alsacienne de Constructions Mecaniques, Belfort



GOODS ENGINE NO. 1182. DUPLICATE OF THE ENGINE NO. 1200. GREAT NORTHERN RAILWAY OF ENGLAND.
Built by Messrs. Burnham, Williams & Co., Baldwin Locomotive Works, Philadelphia, Pa., and exhibited by the builders.

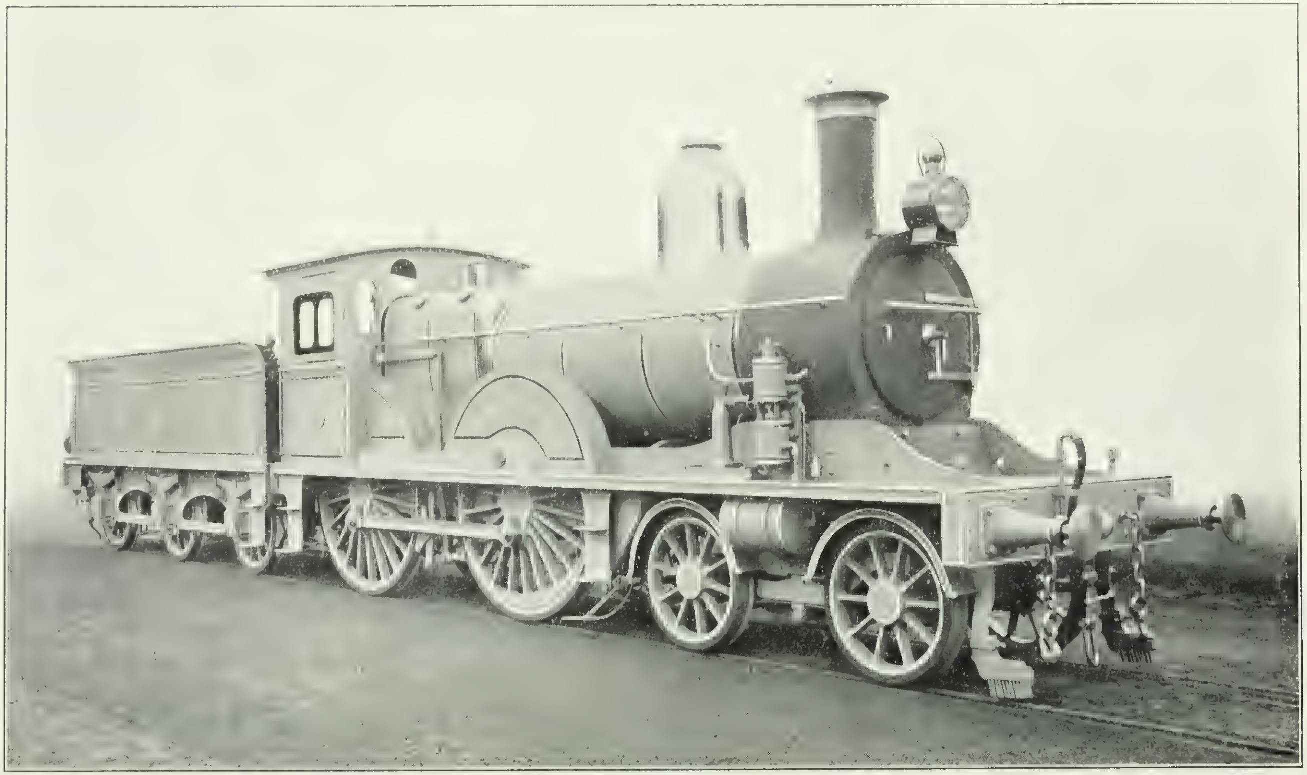
of the Great Central line. Had the Great Northern and the Great Central companies cared to exhibit at Vincennes, it is highly probable that they would have sent their latest single-wheelers as their newest and most interesting types.

But, on the other hand, there is the adversely significant fact that the Great Eastern, which has been one of the three most consistent votaries of single-wheelism since its earliest days, and whose present able locomotive superintendent, Mr. James Holden, brought out only two years ago an entirely new single-driver type, is represented this year at Vincennes by a coupled express engine—a magnificent one, too. And, further, Mr. Holden himself informed me at Vincennes that on mature consideration he did not intend to build any more single-wheelers. It is an interesting coincidence that the last time I met Mr. W. Dean, chief mechanical engineer of the Great Western Railway—a line which has never hitherto wavered in its preference for the single-driver type in express service—he informed me that, in view of the performances of his latest coupled type, he too would construct no more single-wheelers. Neither F. W. Webb nor Mr. Wilson Worsdell, the chief mechanical engineers of the only other British railways exhibiting at Vincennes, has ever built any single-wheelers at all for his line, although each has rebuilt and improved construct no more single-wheelers. Neither Mr. F. W. Webb nor Mr. Pollitt, who built the new single-wheeler for the Great Central, has just retired from his position, and his successor's antecedents rather discourage the idea that he will perpetuate the type, it would appear that Mr. Johnson and Mr. Ivatt will be the only British engineers to continue building single-driver locomotives, and thus the almost total absence of the type from the Vincennes show is, as I remarked at the



FOUR-CYLINDER COMPOUND FOUR-COUPLED EXPRESS ENGINE NO. [illegible].
LONDON AND NORTH WESTERN RAILWAY, ENGLAND.

Designed and built at the company's works, Crewe, by Mr. F. W. Webb, chief mechanical engineer; exhibited by the company.



FOUR-COUPLED EXPRESS ENGINE "KONINGIN WILHELMINA." STATE RAILWAYS OF HOLLAND.

Built by Messrs. Neilson, Reid & Company, Hyde Park Works, Glasgow, and exhibited in the British section by the builders.

outset, distinctly significant of a predominant tendency in British locomotive-building practice.

A second prominent exception offered by Great Britain, the motherland of railways, to the tendency of the whole world outside her boundaries, consists—if I may take her Vincennes exhibit as the criterion—in her disinclination to adopt the compound principle for locomotives. Of the four purely British exhibits, only one is constructed on the compound system, the engine "La France," No. 4000—she being the four-thousandth locomotive built at the famous Crewe works of the London & North Western Railway Company. All the rest are non-compound. Among the exhibits of all other countries, the proportion of compounds to non-compounds is, I should think, quite 10 to 1, if not more. This strange discrepancy in national practice raises another question, and a large one, which I must leave to be dealt with later.

Meanwhile, pursuing my plan of noticing first, in my general review, the prominent exceptions to prevalent locomotive-practice, I must mention two engines of a most extraordinary character which I am unable to treat fully on this occasion, but which I hope to describe and illustrate in a subsequent article. One of these is so singular in the salient feature of its design that, had not the idea been indignantly repudiated by its designer, one would have felt impelled to regard it as a huge scientific practical joke. It is a four-coupled compound express engine built by Krauss, of Munich, for the Bavarian State Railways. It may be described as quasi-"Atlantic" in its type, having a small pair of carrying wheels behind the fire-box, two pairs of large coupled driving-wheels and a four-wheeled leading bogie. The cylinders are inside, but that is a mere detail. The astonishing peculiarity of this engine is that its two pairs of bogie wheels are placed so far apart as to admit between them a third pair of wheels, 3 feet 3¾ inches in diameter, and that this third pair is driven by a pair of small outside cylinders, the combination producing what is called an "auxiliary" engine—equivalent to the "donkey" on board a steamer. Further, this pair of small auxiliary drivers can be raised from the rails, or pressed upon them, as desired, by means of a lever. The object of this eccentric appliance has proved a tough puzzle to most visitors. One, a British engineer of no mean standing, hazarded the conjecture that the tiny auxiliary wheels and cylinders were to be used to move the locomotive about the yard, so as to give the big wheels and cylinders a rest. This suggested to him a humorous comparison with Sir Isaac Newton's absent-minded provision of a large aperture in the door for his large dog to pass through, and a small aperture for the small dog! Naturally the designer was outraged at so disrespectful a reference, and he promptly explained that his "real intention is to have a locomotive, which, in general, has the qualities of a four-coupled engine, but is able to increase, every time it is needed, its cylinder power as well as its adhesive weight in the proportion of 3 to 2, so that it can exert temporarily a tractive power corresponding to six-coupled wheels. In such cases, viz., in starting and accelerating heavy trains, or in ascending steep gradients, the auxiliary axle can be pressed down, its cylinders switched in, and the small engine used as a pilot for the main one. As the assistance of the auxiliary engine can only be wanted at a limited speed, say at the most 65 kilos. (40 miles) an hour, the diameter of its drivers can be made considerably smaller than that of the main drivers."

I must leave this matter for the present, as in this article I am taking merely a general survey of the exhibition and its salient characteristics. But clearly the point is one upon which a good deal can be said.

The other locomotive which struck me as prominent among the relatively few eccentricities of design was the huge six-coupled express engine built at the Florence Works of the Adriatic Railway of Italy, and numbered "3701." Practically it is a six-coupled express bogie engine which has the four-wheeled bogie at the trailing instead of the leading end—as these terms are commonly understood. But in the present case one has to divest one's mind of these normal views of relative positions. For what would be the *trailing* end of the engine, according to the usual practice, is treated as the *leading* end in this instance. That is to say, the engine runs fire-box foremost and smoke-box behind, and the cab is closed in with a prow-shaped end containing six large windows. But, it will be asked, where does the engine carry her supplies of water and fuel? That is a question whose authoritative settlement must be postponed until a later article. For the present I must content myself with observing that coal bunkers of considerable size are fitted on both sides of the fire-box and foot-plate, while the smoke-box end of the engine—I cannot call it the "front" in these circumstances—is followed by a very long cylindrical tank mounted on a six-wheeler frame. In the rear of the tank is a second, but smaller, cab. The whole aspect of this vast but eccentric locomotive is such as to inspire puzzled amazement amounting almost to awe.

Another point which struck me as singular in connection with the locomotive exhibition was that an engine built by Messrs. Burnham, Williams & Co., at the Baldwin Works, Philadelphia, for the Great Northern Railway of England—being in fact one of that series of goods locomotives to whose construction for the British service, and to the problems consequently suggested, I referred in three articles which appeared in THE ENGINEERING MAGAZINE last year*—is shown *in the British section* as an exhibit of the Great Northern Railway Company. This seems to me to be susceptible of misconception and somewhat misleading, but possibly there may have been reasons for the course which have not yet been pointed out to me. I illustrate the type. In this connection, it is noteworthy than the engine, "Koningin Wilhelmina," which was built by Messrs. Neilson, Reid & Co., of Glasgow, for the Dutch State Railway, and which I also now illustrate, is expressly shown as a British exhibit and not as a Dutch one. It would be interesting to know the reason for this difference of treatment.

One of the most remarkable locomotives in the entire Exhibition is the great four-cylinder compound, four-coupled, 10-wheeled express engine of the "Atlantic" type, No. 2642, designed by M. du Bousquet, the able ingénieur en chef du matériel et de la traction to the Chemin de Fer du Nord, on the de Glehn compound system, and built by the Société Alsacienne de Constructions Mécaniques, at Belfort. It is shown by the Nord company and the exhibitors have adopted the exceptional course of having two duplicate engines built, absolutely identical in every particular, the one being on show at Vincennes, while the other is exhibited to the public outside in actual work on the very fast expresses of the Nord line. This novel plan struck me as remarkably effective and impressive in view of the superb work accomplished by the running engine of the two sisters. Of that I shall have more to say subsequently.

I am indebted to M. de Glehn for the photograph from which my illustration of this engine is taken; to Messrs. Neilson, Reid & Co. for the photograph of the engine built by them for the Netherlands, and to Mr. F. Moore for the photographic originals of my other illustrations.

(To be continued.)

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* Mr. Rous-Marten's widely-noticed articles on this subject appeared in the issues of THE ENGINEERING MAGAZINE for July, August, and September, 1899.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

IV.—THE PRODUCTION DEPARTMENT: THE EXECUTION OF THE WORK.

THERE are two considerations involved in the arrangement of machinery and shop departments in a factory building. The tools must be arranged so as to secure the least loss of power in transmission from the generating source, and both tools and departments must be arranged with due regard to facility and rapidity of handling of parts. As far as possible a piece or machine should travel, in its processes of manufacture, from one end of the shop toward the other. The most economical arrangement, so far as handling is concerned, is one in which the piece or machine has to be carried only short distances and in the same direction, instead of being carried to and fro from one end of a shop to the other in its various stages. An arrangement which would provide for the most economical handling, however, may not be the best from a standpoint of economic consumption of power. The factors of power efficiency and rapidity of handling are both continuous in their action, and how much one will outweigh the other depends in any individual case on the particular work done in that shop.

The final best arrangement is a matter which deserves careful mathematical calculation. This question, like many others, is apt to be decided in too off-hand a manner by a shop superintendent. It is certainly true that an experience of many years in shop work is a great aid in developing correct judgment in the deciding of this matter, as well as of the very important one of rates for piece-work or premiums; but accumulated data and mathematical calculations will frequently compel an experienced shop man to confess—sometimes very unwillingly—that he has committed errors in judgment by making an off-hand decision to which he has felt himself bound afterwards to adhere.

Prof. Diemer's papers began with the issue of THE ENGINEERING MAGAZINE for June, 1900. The preceding articles have been :

The Systematized Classification of Shop Orders.
The Production Department: Bills of Material.
The Production Department: Store-Room Management.

In very small machine shops it is not a difficult matter for the shop foreman to carry in his mind practically all the work he has to do on the orders he has in hand, but when the establishment has developed to a stage where perhaps a hundred hands are employed in the machine shop, assistance in the way of certain forms and clerical labor becomes not only an absolute necessity but a decided economy as well. Without such assistance, it is only a man of unusual capacity who will not find himself doing certain classes of machine work in two, three, or four lots, when a careful assortment of the orders in hand would have enabled him to do the same work consecutively, of course to much greater advantage.

While at first sight it might seem desirable to lay in a large stock of smaller parts of machines, irrespective of orders in hand, a more deliberate consideration will generally lead to the conclusion that it is unwise to provide more than a very limited excess of such parts over and above what is required for orders in hand. The reasons for this conclusion are two: First, the shop will be paying out money for labor and material which may not be converted into ready cash for some time to come. Second, minor changes in design are a certainty—which no one who is familiar with the constant evolution of machinery will deny—and in laying in a large stock of small parts a shop certainly exposes itself to the loss entailed by having on hand a considerable amount of material whose only value is its weight as scrap. Take a walk through the store-room of almost any large establishment, and ask the store-room boy "What is this?" and his answer will frequently be, "Oh, that's a lot of pieces that we used to use on our old style of machine. We don't use them now. Here is what we are using now," and he points out an equally large or larger stock of pieces of a different design, which the necessities of trade may require to be superseded at an early date. In certain classes of work it may be necessary to have on hand particular parts of old-style machines, delays in the replacing of which might cause sufficient loss to a customer to involve the loss of his patronage to the shop, but such particular parts are exceptions and what particular pieces they are the manufacturer knows best.

The "Sub-Order" system is a scheme devised primarily for the purpose of assorting all work in hand into the distinct operations involved. This separation forms a reliable basis for estimating the number of hours of work that any particular department or tool has ahead, and is a guide to accurate promises of delivery. It is *prima facie* evidence in considerations involving the addition or cutting off of labor, or the purchase of new tools. The system may be briefly outlined as follows:

In addition to the general order or bill of material, each section is furnished by the shop office a set of "sub-orders" for each order. Each sub-order covers only the work that can be done by one tool or one class of workmen.

A practical form for the sub-order is as follows:

SECTION ....
SHOP ORDER..............
SUB-ORDER................
DRAWING NO..............
PATTERN NO.... ....
Number of Pieces................
Work to be done on Tools Nos.................
Operation ....
....

Record of Time spent on above Sub-Order:

Date	Check No.	No. Hrs.	Date	Check No.	No. Hrs	Date	Check No.	No. Hrs.

Total Time spent on Order .... Hrs.

.... Perforated line ....

Section Foreman will tear off this slip and return to Shop Office. I estimate that the above operation will require............Hrs.

Shop Order.................
Sub-Order...................

....
Foreman Section............

The sub-order is issued in triplicate from a stub-book consisting of two perforated and one unperforated sheet alternating so that one carbon copy remains in the book, while the original is issued to the section foreman, and one carbon copy is sent to the time-keeping department. They are numbered as issued, beginning with No. 1 with the first sub-order issued under any one shop-order number.

The section foreman has a file board on which he keeps his sub-orders. He will usually find it most convenient to place next each other those sub-orders which cover similar operations.

The perforated slips at the bottom of the sub-order sheet are used to determine how much work is ahead. The foreman puts down his estimate of the number of hours required to do the work, and returns the slip at once to the shop office. A clerk in the time-keeping department keeps the estimates reported on these slips balanced up each day, so that a fairly accurate estimate of the total hours of work ahead for any department or any tool is always at hand. He should also check up the time actually spent on the sub-orders against these estimates, and report to the foreman any marked discrepancies. He needs to be strictly enjoined, however, that it is not his business to "call down" or criticise shop foremen for making errors in their estimates.

The general shop foreman should not be burdened with the task of writing out sub-orders. This work should be given to a competent man who need not be interrupted in his work. Usually a man fitted by previous training in the best possible way to fill the position of a clerk to issue sub-orders can be drawn from a class which is being developed in our larger manufacturing centers, and it is a class the developing of which needs the best encouragement that can be given by machine-shop managers. I refer to those boys and young men who enter machine shops as apprentices and who have sufficient ambition to study mechanical drawing. A course as an apprentice, followed by a period in the drafting room, will educate a clerk thoroughly competent to take hold of shop forms and data in an intelligent manner. Fresh college graduates, while frequently well-capacitated for such clerical work as this, are apt to consider the job as humiliating, and in consequence are not so likely to work the position to its fullest possibilities as a youth of the class to which I have referred may be expected to do.

The shop foreman must be among the men and tools and not at a desk. Over-burden your shop foreman with clerical labor, and a certain proportion of the mechanics will be governed by that unwritten machinist's law by the dictates of which he uses that cutting speed, feed, rake, and any other available method which does the least amount of work in the greatest amount of time. The fact that this unwritten law does exist is a most potent reason for appointing to the position of shop foreman a man who has operated machine tools in person, with his own hands. A man may be a most excellent engineer and designer or manager, and still be totally unfit for the position of shop foreman.

The following office work is necessary to determine from the sub-orders a record of the cost of every operation on every piece that goes through the factory.

The cost or time-keeping department is furnished daily a carbon copy of every sub-order issued. The factory also furnishes daily a list of all sub-orders completed the previous day. Instead of a list, the foremen's copies themselves as completed may be turned in for this purpose.

The time-keeping department enters daily, on its carbon copy of sub-order, a record of the time, number of man, and rate for all labor on the sub-order. As soon as the sub-order has been announced complete, these entries are summed up and the results entered on a card index, the form of the card being as follows:

DRAWING NO. PATTERN NO. ARTICLE.

MATERIAL. WEIGHT. COST OF MATERIAL.

Order No.	Sub-Order No.	Operation.	No. pcs.	No. of Man.	Time.	Rate.	Total Labor.

The cards are filed consecutively according to drawing numbers. As there may be several different patterns shown on one drawing, there may be several cards bearing the same drawing number, the individual cards covering various patterns mentioned on the drawing in question. The operation and piece are easy to locate in the card cabinet by referring to the proper drawing number, as mentioned in the bill of material.

It will be at once apparent that a card record such as this affords a most reliable basis, not only for the cost of each operation, but for establishing piece-work and premium rates where such systems are in vogue in the shop.

I came into contact with the piece-work system the very first day that I entered a machine shop, and the impression as to its questionable efficacy made on me at that time has remained with me ever since. It was during a summer vacation while I was attending college. I had secured admission as an ordinary "hand" in a large manufacturing establishment in which piece-work was the general rule. Fired with the ambition of youth and the novelty of the work, I was working away with a will, when one of the men tapped me on the shoulder, and said: "See here, young fellow, you're working too fast. You'll spoil our job for us if you don't go slower."

It is unquestionably true that even in flourishing establishments, where the piece-work system has been in successful operation for years, the majority of the workmen are opposed to it. It is also true that they look with the utmost suspicion at the premium system, feeling that it is merely a lamb's skin to cover the same old wolf. I have seen an effort to introduce the premium system made with the best of intentions on the part of the management, with the only result that the majority of employees figured out how much more money the company had made than they had out of the scheme, or, as they put it, "out of how much the company had beat them." This simply illustrates the feeling which exists. What a campaign of education may accomplish in removing this prejudice remains to be seen.*

But without regard to the question of piece or premium rates, the card record above explained is a most reliable index to show which employees are the money-makers and which ones are the p[illegible]-destroyers. One or two entries will not determine this, but several months' careful study will undoubtedly do so.

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* A most significant instance of what may be accomplished by patient effort of the manager and reason on the part of the men is brought to our notice just as these pages are being closed. Mr. Norris, whose story of his well-thought-out attempt to introduce the premium system and of the bitter and seemingly ineradicable opposition of the organised labour in his works made so interesting a feature of our issues for January and February last, writes us as follows: "I know you will be interested to learn that I now have the premium plan under full swing in the shop—the last 'kicker' having accepted it last week. * * * A few men never ceased working under the plan since the date of its first introduction, one and one-half years ago. It was not until three months ago, however, that it came into any thing like general use, and it is only two weeks since the last man to whom we can apply it has accepted it. * * * This man remarked: 'It is to the interest of machinists to keep

It is certain that a fluctuating income in itself is always disturbing to the peace of mind of a workman, and most piece-workers would be far better satisfied if their total annual income could be equally distributed. There are in any shop certain workmen who stand head and shoulders above the ordinary man in earning capacity, and the management can often well afford to pay such men higher than union wages. I have heard managers say that if they were to do this, every body else doing similar work would immediately ask for an increase. But the experiment has to my knowledge been successfully tried in at least one instance. An officer in an establishment which has been exceptionally successful in the manufacture of machine tools, and which handles a large foreign trade, attributes much of the success of the company to the fact that they have made an open practice of employing, at higher than union wages, men who have "graduated" from other machine shops. This establishment pays as high as $3.00 and $3.50 per day for first-class machinists, and as its business has increased there has been a constant influx of men to its ranks from a nearby etablishment whose mechanical and machine methods were well-nigh perfect, but who drew the line at $2.25 per day as the maximum salary they could afford to pay.

The practice of keeping account of the time taken by different workmen to do similar work is bound to have a good effect on shop discipline, and such data can be easily collected by the methods above suggested, in connection with the determination of accurate cost data, which latter are indispensable in a business of any magnitude.

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the time as high as possible, but if the premium plan is fair to one, it is fair for all.' He made $5.67 (premium) on the first job, saving over 43¾ hours over the best previous record."

This shop, it will be remembered, was the "leading case," referred to by Mr. O'Connell in our June issue—the one in which American trade-unionism would have finally and blindly crushed out the new and progressive systems of labour remuneration. The ultimate success of the premium plan in the Bickford works is of course far from being a solitary example, but this one suffices to show that a single manufacturer, by patient persistence for a principle which is fair and sound and mutually advantageous, can finally overcome even the deepest-rooted predjudices of the unions. This and the recent settlement of the machinists' strike are hopeful signs of progress in the mechanical world.—The Editors.

EDITORIAL COMMENT

A remarkable indication of the far-reaching influence of engineering science is seen in the manner in which the recent gatherings of engineers in London were received. Apart from the value of the papers and discussions, the social features showed the extent to which the engineer has taken his place in the fabric of society, upon which so many important relations depend.

The climax was reached in the visit to Windsor, when the extraordinary privileges granted the visiting engineers attracted much attention. The presentation of the officers of the engineering societies to the Queen was an honour which has rarely been given before, and must go far toward strengthening the ties already existing between both nations represented.

Much of the power which has been wielded by England during the reign of Queen Victoria has been due to the work of the engineer, and the recognition of this fact by the Queen is a noteworthy incident in the annals of the profession on both sides of the Atlantic.

There is a striking suggestion in this for the engineering profession, which is too apt to hold itself quite aloof from political matters, and, indeed, to be rather impatient of them. As a matter of fact, statecraft and handicraft are becoming more closely interwoven every day. The great undertakings which the engineer directs and the vast interests he represents are very dependent upon political administration at home and abroad, upon internal legislation and the conduct of foreign affairs. The essence of colonial expansion is industrial opportunity, not mere territorial addition. It will be well if engineers realise their position and influence, as those in control of the government recognise it, and learn to act promptly decidedly, and unitedly in supporting or advising the government in matters touching the national welfare.

* * *

The vital connection between the price of iron and business activity, so ably argued by Mr. Hull in our August issue, is proven again by the stimulus to enquiry and the movement toward new undertakings which has sprung from the recent decline in the cost of iron and steel. The natural result is a manifest tendency toward renewed stiffening of prices, but there is no reason to anticipate any return to the extreme figures ruling some months ago. In fact. it seems justifiable to expect a gradual settling down to normal figures. These will still leave abundant margin for profit to the furnaces and mills when accompanied, as they will be, by a corresponding movement toward sanity and reason among the sellers of ores and fuel.

The efforts to enlarge production under the pressure of the boom will certainly leave lasting effects in the direction of increased capacity, assuring fuller supplies of iron products in the future. In this enlargement of output the United States will have, no doubt, more than a proportionate share. The Carnegie works, which last year turned out 2,600,000 tons of steel —one-tenth of the world's product—is expected this year to deliver 3,400,000 tons, probably 13 per cent. of all the steel made in the world—more than half as much as the total output of Great Britain. The average rate of increase the world over is 12 per cent. per annum ; the rate of increase of the Carnegie plant is about 25 per cent. per annum. It is the menace of this vast production, under conditions approaching the ideal in economy, which causes the apprehension among continental steel makers more fully touched upon on page 920 of this issue. There is no doubt it means that British and German ironmasters must be content with lower prices, but there is no doubt either that they have a large margin of yet unrealised economies in manufacture which they will soon be forced to avail themselves of—all, eventually, to the advantage of the steel user. Cheap steel is the fundamental requirement of engineering activity and industrial prosperity. Cheap steel, wherever made, is at the command of buyers the world over. Cheapening of steel is in itself of so enormous advantage to enterprise of every character as to completely outbalance any local injury caused by the shifting of the centers of profitable steel-making.

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The *Builder*, commenting upon Mr. James O'Connell's contribution in our June issue, says that his article, "if it refers to American workshops (it is not always easy to say whether an article in THE ENGINEERING MAGAZINE is American or English, unless specially stated), is quite at variance with the view given by the writer in the *Times*, referred to in a note on another page."

It is true that it is the peculiar province of THE ENGINEERING MAGAZINE to draw upon the leading thought and action of all the great industrial countries for its writers and its themes. The range of the magazine is as widely international as are important developments in engineering practice. But there need not be the slightest doubt as to the source of any particular article in its pages. It is strange that the *Builder's* reviewer could read Mr. O'Connell's paper sufficiently well to discover his views, and still remain in doubt whether he referred to English or American workshops.

He is introduced in the editorial preface to his article as "the official exponent of organised American labour." In the very first paragraph he hangs his whole argument upon the positions assumed by "the last convention of the International Association of Machinists, which was held in Buffalo, N. Y." Five times more he defines his views as those of the "International Association of Machinists," the distinctive American association corresponding to the British "Amalgamated Society of Engineers"; three times he expressly states that he speaks for "the average American machinist." And in the department of Authors and Papers, in the front of the magazine, his biography and career are given in full: Born at Minersville, Pa., apprenticed in American shops; associated since 1893 with the most characteristic of American labour unions.

THE ENGINEERING MAGAZINE invited Mr. O'Connell's contribution because, having frequently treated the question from the employer's standpoint, it believed genuine advantage would result if it (again quoting the editorial preface) "opened its pages to the leading exponent of American organised mechanical labour," and asked him "to join in the discussion and to define the attitude of the employee." The magazine made it very clear at the opening that it completely dissented from Mr. O'Connell's views; but where has the *Builder* been nodding, not to know a guest so clearly announced and so fully introduced?

* * *

Mr. Buel, in his interesting article on Porto Rico in our August number, ended his criticism of the "Model and Training School" by felicitating the Porto Ricans upon the fact that at least it was not fireproof. The sheets of his article were hardly off the press when we received from him a newspaper clipping telling of the burning of the building. "No fire in my recollection," he says, "has been less lamentable. A disgrace to the American government has been destroyed. After General Meigs had finished the Pension Office in Washington, he asked Phil Sheridan what he thought of the criticisms passed on it. Sheridan said: 'Well, Meigs, the worst thing about it is, they tell me the damn thing is fireproof!' Let us thank the architect of the only Model and Training School that he did not make it fireproof."

REVIEW OF THE BRITISH PRESS

Combination and Competition.

MUCH has already been written about foreign competition and its consequences, and the subject bids fair to become rather wearisome, but since it is a very real factor in manufacturing and commercial affairs it should really be discussed from every practical point of view. A recent editorial in *Engineering* takes up the relation which trade combinations bear to this question, considering very thoughtfully the influence of the combinations so much in vogue in the United States, and comparing with these some which have been formed in Great Britain. The foundation of successful competition is the reduction in cost of the product, character and quality remaining unchanged. Formerly the prime element of cost was the wages of the man by whom the article was made. With the introduction of machinery the product was cheapened in this respect, until the item of so-called "general" expense has become equally important, if not more so. The labour cost of an article has been diminished, not by reducing the pay of the workman, but by increasing his output.

The general expense per unit of product is naturally diminished with the increased output, since the total expenditure is divided among a greater number of units, but this method alone will not suffice to reduce this element of cost, and hence the next step has been to reduce the total amount of general expense by combining a number of manufacturing establishments under one management. This enables expenses of supervision and direction to be greatly reduced, and at the same time aids to improve the product.

Taking a large product, such for example as a ship-of-war, and it is evident that the union in one firm of the divers manufactures which are required in its construction lessens not only the charges of supervision, but also results in a reduction in the time-cost of the work, especially where all the contributory establishments are under a common direction, working in unison.

"Under the conditions still generally obtaining in Great Britain there are between the raw material and the ship the iron ore miner, the coal miner, the ship owner carrying the coal, ore and other materials, the iron master, the steel maker, and probably the iron founder, forger and marine engine builder, each involving separate and avoidable charges, as well as profit.

"Under the new conditions, which are aimed at by the combinations which have been perfected, or are in contemplation, there would be far fewer intermediaries between the raw material and the finished product ready for its carrying trade."

Although such a combination eliminates, to a certain extent, the competition between those who supply the material, this fact does not tend to increase the price, since the price is mainly governed by the final competition. The element of competition is not reduced when the steelmaker joins forces with the shipbuilder.

"If a shipowner who wants a ship can get two or three builders to tender he is not concerned where the steel and iron come from. What he is chiefly interested in, next to cheapness in cost, is quick, or, at any rate, certain delivery, and unity of purpose on the part of those concerned in the various parts of construction and fittings. Work carried out by a crowd of contractors, who have no common interest, can never be so well done as when the whole is executed by a single firm, and, although it may not be possible to point to faults that call for remedy, yet there is departure from that standard which merits the definition first-class."

That the truth of these facts is being appreciated in Great Britain is demonstrated by the steady increase in the number of combinations and amalgamations effected during the past few years, and by the indications that many others will probably follow. Space will not permit the enumeration at this time, nor is it necessary; it is the principle which is sought to be established.

There is another feature in connection with such combinations which should be considered; the ability of strong combinations of capital to effect the employment of methods which would be impossible on a smaller scale.

"The competition of American and other foreign countries in the manufacture of iron and steel goods makes it incumbent upon British manufacturers that they should effect all the economies and improvements possible in order to meet these rivals; and in the way of economies there is everything to be said for the control of a big company of its main sources of supply. All the leading American establishments do this, and much of their success is, no doubt, due to their foresight in acquiring and developing iron-bearing ground when it was cheap."

The extent to which such industrial combinations may develop into the still greater combinations, called in America "trusts," is a matter which cannot be considered here, and in any case the objections which may properly be made against them do not impair the strength of the contention that combinations enable a better product to be made at a greatly reduced cost and in far less time than by the old methods.

Power-Station Design.

A PAPER presented by Mr. Philip Dawson before the Tramways and Light Railways Association during the recent exhibition, and published in the *Electrical Review,* contains some useful and extremely practical points about the general conditions governing traction power station design.

In the first place, it is pointed out that a low cost per unit of electrical energy at the switchboard does not necessarily mean a low cost per car or per train-mile, as it is possible that, in order to secure cheap current, the power station may be so located as to cause great expense in feeders, sub-stations, and loss in transmission. While this applies both to traction and to lighting, the demand for current for both purposes is increasing so rapidly that lighting is becoming a secondary consideration.

Comparing the differences between lighting stations and those designed for power only, a number of interesting points are made.

"The average number of hours per annum during which a lighting station will be running full load will probably never be equivalent to more than three months' continuous running per annum, that is to say, taking the total Board of Trade units generated in one year, and seeing how long the plant under consideration would have to run its full capacity continuously to generate this amount, this time would probably never exceed three months. Taking a representative traction station, the time of continuous running would probably be at least 9, and in some cases 10, and even 11 months.

A lighting plant must in three months earn enough money to pay working expenses and to pay interest and allow for depreciation and sinking fund for a whole year, whereas a traction plant has from 9 to 11 months to do the same thing.

"A lighting plant is on an average practically at a standstill 18 hours a day, while a traction plant is running 18 to 20 hours a day. Economical boilers, engines and electrical generating and transmission devices are therefore far more important in a traction than a lighting plant, because it is well known that running at very light loads and keeping the fires banked and the boilers, steam pipes, engines, etc., hot, uses very nearly as much fuel as running them at full load.

"Furthermore, whereas in a lighting plant there is ample time to overhaul the plant and execute necessary repairs, the men during the day have little or nothing to do and can well do this work. In a traction plant there is little or no time to do this. The conditions are quite, if not more, arduous than on a ship. There at least every few days or few weeks the whole plant is entirely shut down for several days and can be taken to pieces and overhauled.

"Unexpected and rapid overloads must be able to be supported by the traction plant, which is not generally the case in lighting.

"In a traction station it will be seen that a far greater figure is cut by the cost of generation, pure and simple, than in a lighting station, and that the question of interest on capital expenditure and sinking fund is relatively smaller in the former than in the latter."

Tabulating the figures, which are deduced from actual practice, Mr. Dawson shows that the cost of power when generated for power and traction purposes is only about one-quarter of that when generated for lighting purposes.

The economies to be effected by judicious arrangement of distribution are discussed at length, and, compared with the system of feeders, distributers, track, and overhead line, the cost of the power-station is a comparatively small item. The saving which can be effected by a properly designed station is very great, and a little extra expenditure is in many instances well justified.

The advantages in the use of polyphase currents are shown to be great, and Mr. Dawson advises for anything above 5,000 kw. capacity, one polyphase station, operating rotary-converter sub-stations.

"All engine builders who have had experience in tramway work now make an entirely different kind of engine for traction from that which they supply for lighting stations. The conditions under which a tramway engine works are, if anything, more onerous than those of a rolling-mill engine. A slight variation, either in number of revolutions per minute, or in angular velocity per revolution, is of the greatest importance in a traction station, whereas it is of small importance in a rolling mill.

"A uniform speed is especially important where compound wound dynamos are run in parallel direct on to the line. If the momentary difference in speed between two engines exceeds very narrow limits, the voltages of the machines differ, and cause very heavy currents in the equalising bars, and largely increased core losses, hence great waste. If the difference becomes too great, one of the generators may even be reversed. Where polyphase machines run in parallel, constant speed is of even greater importance to keep the machines in step. In cases where shunt wound generators with heavy batteries of accumulators run in parallel on the line, the question of engine regulation is not so important.

"A traction station where compound wound dynamos are used should be so arranged that, if the normal load be suddenly thrown on or off an engine, the speed shall not vary more than 2 per cent. either way. In some cases a maximum variation of 1½ and 1¼ per cent. is all that is allowed. Where polyphase currents are used, constant speed is of even greater importance, and a guarantee should be required that under no circumstances shall the angular velocity during one revolution vary more than ½ (1½?) per cent., and in some cases not more than half of 1 per cent. With heavy flywheels, and governors properly designed for tramway work, it is quite practicable to fulfill the above conditions."

Recent Locomotive Practice in France.

THE paper of M. Edouard Sauvage, recently presented before the Institution of Mechanical Engineers, upon the developments in locomotive engineering in France, contains much that is valuable and instructive. The increase in power of the locomotives on the French railways is a matter which has been observed by engineers of other countries already, but a detailed account of the development by one so well adapted to give accurate information as is M. Sauvage, is especially worthy of notice.

The feature which makes the first impression upon the reader of the paper is the large number of compound locomotives in use in France; indeed, the paper might almost be entitled "compound locomotives in France," there being more than 800 four-cylinder compound engines in service or under construction. These locomotives vary somewhat in design, according to the railways on which they are used and the service for which they are intended. "The four cylinders drive either two, three, or four axles. With two driving axles the machines have large wheels, and are intended specially for working express trains, but they may also be employed advantageously for the heaviest passenger trains, and even in certain cases for goods trains. The locomotives with three axles have also large wheels. They draw easily long goods trains or heavy passenger trains; they have been employed to work express trains, but exceptionally rather than regularly. This type of engine renders very great service, since it is suitable for almost all trains; it allows considerable increase in speed for goods trains, which becomes more and more necessary on the network of the principal French lines."

M. Sauvage gives in his paper a number of schematic illustrations, showing the development of the compound locomotive in France since 1885, with a tabulated list of the four cylinder compounds in use or on order on January 1, 1900; the total foots up 803, and does not include Mallet two-cylinder locomotives used on light railways of the metre gauge.

Careful comparisons of these compound locomotives with equivalent two-cylinder engines have shown that the fuel economy attained by a use of the compound engines is at least 12 per cent. In making these comparisons every care was taken to put the engines to various duties, to employ exactly the same kind of fuel in all cases, and to change the men often. Although this is not so high an economy as has been claimed elsewhere for compound locomotives, yet it is the result of very careful investigation, under operative conditions, and is probably within the figures which would be obtained by special tests.

In general arrangement the plan of construction which has found favour in France, is that with the low-pressure cylinders inside, connected to the forward cranked axle, the high-pressure cylinders being outside and connected to the same axle. Side rods are used to drive the rear axle, and a bogie is used forward. For the valve gear the Walschaert is used outside, and either the Walschaert or the Gooch inside. There are two lifting shafts arranged to be operated separately, or connected in any desired relation, so that almost any desired steam distribution can be obtained.

For starting, high-pressure steam is admitted into the receiver, and in addition a relief valve is provided for the exhaust of the high-pressure cylinders, so that, if necessary, the engine can be converted into a simple four-cylinder engine.

Belpaire fire-boxes are generally employed and ribbed tubes are frequently used. Experience has shown that ribbed tubes are just as serviceable as ordinary tubes having the same internal surface in contact with the hot gases. A deposit of coke sometimes forms between the ribs, but this is removed from time to time. Steam pressures are carried as high as 200 to 228 pounds per square inch, in order to permit the full benefit of compounding to be attained. M. Sauvage's paper gives many useful details in regard to the construction and operation of these locomotives, and from its extremely practical nature it must be regarded as a very valuable contribution to railway literature. This is especially the case in view of the advance in service which has been made of late on the principal railways of France, and there is little doubt that much of the success which has there been attained with heavy high-speed trains is due to the improved powerful compound locomotives employed. Compounding is certainly an assured fact, and while there may be differences of opinion as to minor details, the general arrangement of the principal engines described by M. Sauvage appears to be the most successful yet employed.

Cheap Power.

In view of the increasing cost of fuel, upon which by far the greater part of our prime movers depend as their source of energy, a recent editorial in *The Engineer* is timely. Other countries have in many cases available water power, but in England coal is the prime source of power, and the increased value of coal brings into unusual prominence schemes for obtaining the largest possible quantity of power out of the smallest possible quantity of fuel.

It is admitted that there are other available sources—the wind, water, and the sea—but methods for using these, in England at least, have not been reduced to the practical stage.

Coming back, then, to coal, the question at present appears to be the best method of obtaining the highest efficiency by its combustion and conversion into power, and at the present time attention is strongly directed toward internal combustion motors, or, as they are more commonly called, gas engines.

Formerly these were limited to small powers, but of late the capacity has continually increased, until we have at the Paris Exposition the great Cockerill blowing engine, giving 1,000 h.p. with illuminating gas, or about 700 h.p. with lean blast-furnace gas. The fact that orders have been taken for more than 70 of these engines is evidence of the interest which is taken in this subject, while on all sides we see the makers of gas engines increasing the capacity of their products. Where blast-furnace gas is not available, producer gas may readily be substituted.

"It is not to be supposed that those who have steam engines now will reject them in favour of gas engines; nor is it desirable that they should attempt it. The whole cost of power is made up of many items, and it does not necessarily follow that because a gas engine plant uses less coal per horse-power per hour than a steam engine plant, that it is, therefore, the most economical all 'round. Various factors come into operation and modify the result for good or evil; but when the substitution of gas for steam is out of the question, the millowner ought not to sit down and assume that his engines and boilers do not admit of being improved. The augmented price of coal should lead to a complete overhaul of plant. We can do no more than hint at certain things that may be done with advantage. Boilers should be carefully scaled and kept clean. Great quantities of heat are wasted when furnaces and flues are covered thickly with non-conducting scale. Valves and pistons should be overhauled, and certainty obtained that they are not leaking. Tight valves and pistons are the exception rather than the rule. Many engines are running with far too much clearance. The reduction of this will be found remunerative. It may be done by bolting plates to the piston faces, or by turning so much off the cylinder cover flanges as will let the covers further into the cylinders. Reduction of clearance often effects an economy so considerable that it is next to impossible to account for it. But the most ready method in a large number of cases of saving fuel lies in improving the vacuum, or, more exactly, in reducing the back pressure in the low-pressure cylinders. The importance of this is curiously overlooked. Let us take an engine with a low-pressure cylinder 55 in. diameter, and a piston speed of 600 ft. per minute, then 1 ℔. per square inch effective pressure represents 43 horse-power. The total power of such an engine, assuming it to be compound, would probably be 800 indicated horse-power. One pound of back pressure represents 5 per cent. Certainly over 40 horse-power is worth having, if, as is often the case, it can be had for nothing."

The Prevention of Water Waste.

THE question of the waste of water is one which has been constantly growing in importance in many great cities, and especially when the introduction of filtration plants is considered does it come up most urgently for consideration.

In a paper presented before the British Association of Waterworks Engineers, at their Cardiff meeting, by M. A. J. Jenkins, this subject was treated mainly to show the relationship between the cost of the water wasted and the cost of prevention and detection of waste, a relation of prime importance from the commercial viewpoint.

Water wastes may be classified under three heads: those due to overdrawing and leaving taps running after use; those due to defects in mains and service pipes, and those due to the use of inferior taps of all kinds and to siphon cisterns.

The first class of wastes are mainly due to carelessness and to an idea among many people that the supply is unlimited. The only remedy for it appears to be the introduction of house meters.

Defects in mains and service pipes are great sources of waste, and being hidden from sight, are not always soon discovered. Mains are sometimes broken through local circumstances, and unless the character of the ground is such that the leaks quickly show themselves at the surface or in the sewers, these are usually first detected through the falling pressure. The increasing use of asphalt or wood paving, upon a bed of impervious concrete, tends to prevent, to a very marked extent, the appearance of leaks at the road surface. By the use of self-registering district meters any increased flow of water during the small hours of the morning becomes an indication of leakage, and acts as a check upon the reports of turncocks, who should be continually examining the pressure in all parts of their districts.

A very fruitful source of waste is found in inferior fittings. This is only partially mitigated by a system of control, any examination of new fittings being necessarily superficial, and unsatisfactory. The free renewal of washers of leaky taps is a plan which has proved very economical, the annual cost not exceeding 2d. per tap, this being far less than the value of the water wasted, since consumers are usually most dilatory in the matter of making repairs of this character.

By the employment of a competent staff of waste inspectors, with a periodical system of house to house inspection, waste may be very greatly reduced. This should be supplemented by district registering meters, above referred to, and a careful use of the stethoscope applied to the outside stop taps. Meters should be periodically examined and tested. Moderately-worked meters remain accurate the longest, but idleness is more harmful than overwork. The annual cost of examining meters at Cardiff has been found to be materially within the saving effected by such testing.

"The necessity for the husbanding of supplies must become more pressing every year; the requirements of sanitation naturally lead to an increased domestic consumption, the requirements of trade are upon the increase, and the growth of populations in the larger towns is progressing at an enormous rate; it is true there are still large areas of gathering grounds unappropriated, but for the most part at great distances from large towns; each year the cost of works is increasing, and if economies can be made in existing supplies and the increased demands be partially, if not wholly, met by the prevention of waste, then it behooves water authorities to make those economies."

The following conclusions are submitted as a summary:

"1. That to keep the supply of a district within reasonable bounds, an efficient system of inspection is necessary.

"2. That a regular and systematic inspection can be carried on at a very reasonable cost, which will certainly be repaid in the value of the water saved.

"3. That the prevention of waste will be facilitated by the introduction of a system of testing and stamping of all fittings.

"4. That within certain limits the expenditure incurred by the execution of 'free repairs' is warranted by the saving of water resulting."

Electric-Power Distribution in Great Britain.

As a result of the inquiry of the Select Committee of the House of Commons into the merits of certain bills submitted for supplying electric energy over extended areas, the question of electric power distribution has been materially cleared up. It has long been admitted that the principal impediment to the rapid extension of the use of electric power has been the dilatory action of the local authorities, who would neither install plants themselves nor permit others to do so. It has also been admitted that there are no insuperable difficulties connected with the generation of electricity and its distribution, from an engineering point of view, and, indeed, in view of the many and large installations in successful operation on the Continent and in America, it certainly seems needless to go into any especial argument upon this point. Notwithstanding the existence of the numerous large plants in Germany, Switzerland and France, as well as the great installations at Niagara and elsewhere, it was only two years ago that a Joint Committee arrived at the conclusion that it was unnecessary to hear engineering evidence to the effect that such schemes were practicable. It was then also admitted to be clear that it was a matter of importance to manufacturers that they should be able to obtain cheap electric power from central sources, so that these elementary questions no longer remained to consume time, while Britain's competitors were busily constructing and operating their works. The hearing at the present time has therefore been devoted mainly to an examination of the desirability of the schemes proposed, and to the treatment of the opposition of local authorities.

A summary of the hearing in a recent issue of *The Engineer* gives a clear account of the result of the inquiry, and an abstract is here given:

The bills under consideration include five plans, providing for electric power supply in Tyne district, in the manufacturing districts of Lancashire, in South Wales, and on the Shannon. In all cases the local authorities have entered opposition, this opposition being based upon questions of interference with roads, about which they are always ready to make a terrible outcry, and of possible competition with their own undertakings. The nervousness about competition with local undertakings is most instructive, since it clearly admits that they realise that their own high prices for electric energy cannot stand in the face of such competition, and can be construed into nothing else than a desire to maintain monopoly in order that such prices may be upheld. The short-sightedness of such a position is evident when it is seen that the whole district must suffer from foreign competition if local competition is not permitted full scope; and in this respect the evidence before the committee dealt with foreign competition, and the relative progress of other countries in regard to the use of electricity. The most important testimony in this respect was that of Mr. Arthur Keen, well known in connection with the amalgamation of the Patent Nut and Bolt Company with the Dowlais works, and other large manufacturing interests in South Wales and elsewhere. Mr. Keen spoke of the disadvantages experienced under present conditions, citing the fact that steel makers in America can get their coal at 4s. per ton and ore at 5s., while the cost of the coal used by them in South Wales is 16s. per ton, and ore 15s. to 20s. per ton. While these figures are impressive they do not bear directly upon the question of the distribution of electricity, but they do show the necessity of doing everything possible to favour cheapness in other directions, in order to assist in equalising this great difference. Describing his observations during recent visits to the United States, Canada and Germany, he related how he found power supplied from central stations, sometimes thirty-five miles away, and showed the great advantage resulting from such a concentration of operation.

The question of local opposition is very clearly seen to be a desire to prevent competition, but this really comes back to a consideration of the fundamental interests of the districts under consideration. To the disinterested observer it seems supremely ridiculous to waste months of precious time gravely discussing questions long ago settled in other parts of the world beyond controversy, permitting valuable trade to be captured by rival nations, not only without effort, but really with positive assistance. Britain's industries are daily being invaded by Germany, Belgium, America, while parliamentary committees are wrestling with local authorities as to "how not to do it."

The present position of the matter, so far as the above mentioned bills are concerned, is announced by the committee in the following paragraph:

"A local authority which undertakes, and is prepared to give, a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply within its district of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide, on reasonable terms and within a reasonable time, a full and adequate supply of electrical energy for any purposes to any company or person applying for the same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose. Any difference arising out of the above questions should be the subject of arbitration, as provided by the general Acts."

This leaves the situation in such a shape as to cause it almost certain that in each case interminable discussions will follow as to what constitute reasonable terms and what is a reasonable time. While apparently placing the matter in a definite position, the clause above quoted really makes further delay inevitable. It is hardly to be expected that the municipalities will throw themselves into this question of power supply with the energy which it demands; nor, in view of past experience, is it likely that they will be willing to concede the privileges to private undertakers.

Is it not more likely that, when they can do nothing, or do not wish to proceed, they will delay and equivocate as they have done in the past, and that under such a state of things as the committee's clause foreshadows, progress, whether on the part of the municipalities or of private enterprise, will, relatively to the progress in other countries, be very slow, and be attended with much expense, uncertainty, and difficulty?

The Properties of Lubricants.

Experience with various kinds of lubricants, especially since the introduction of modern mineral oils, has shown that something more than the mere statement of specific gravity is necessary in order to determine the lubricating value. A recent paper in *The Engineer,* upon the "oiliness" of lubricating oils, discusses the properties upon which the lubricating value of oils depend, and shows the importance of a careful investigation of an oil for any especial service.

After it was understood that specific gravity was not the sole criterion of lubricating value, viscosity became the gauge, and it was held that the best oil was one which possessed the lowest viscosity compatible with a power of keeping the moving surfaces from touching one another, under the conditions of temperature, load, and area obtaining in the bearing to which the load had to be applied.

The relation between viscosity and lubricating power has been observed for about twenty years, and the lubricating power was at first supposed to be inversely proportional to its viscosity. Of late, however, it has been realized that viscosity is not the true measure of lubricating value, and that it rather depends upon another property, which, for lack of a better name, has been termed "oiliness." With high speeds, moderate loads, and good lubrication, it is no doubt the degree of fluidity which principally determines the value of a lubricant for any particular purpose, but when the speeds are slow or very high, the loads great, or the lubrication imperfect, "oiliness" plays the most important part in the reduction of frictional resistances.

The question of temperature enters into the matter as an important factor. Viscosity falls as temperature rises, and the fall is much more rapid among mineral oils than among such as are derived from vegetable and animal sources. Very moderate changes in temperature, due either to the weather, or to the revolution of the lubricated spindle, may be too small to affect the viscosity of a fatty oil and yet large enough to lower the viscosity of a mineral oil, and render it too thin to carry the load.

A good example of the difference between viscosity and oiliness is given from the treatise of Archbutt and Deeley by comparing glycerine and sperm oil. Glycerine is undoubtedly more viscid than sperm oil, and yet the latter feels smooth and greasy when rubbed between the fingers, while glycerine feels harsh. It is hardly fair, however, to consider glycerine as an oil at all, and the speed at which it loses its viscosity with rising temperature does not appear to have been investigated. Many liquids are viscid that have not the least claim to oiliness, and this shows that oiliness is not the same thing as viscosity.

The fundamental idea underlying lubrication is the avoidance of solid friction, and hence one of the important properties of a lubricant is that which prevents it from being driven out when the bearing is subjected to pressure. The extent to which this requirement is met by viscosity alone is questionable. Viscosity, or "body," as it has been termed, is really a sluggishness, due to a sort of internal friction, which causes the lubricant to delay the action of forces tending to press it out of a bearing, but which cannot be expected to exert a final effort. The film of lubricant might ultimately be forced out, were it not for the fact that adhesiveness and capillary action enter to retain sufficient lubricant to prevent metallic contact.

In this connection it is important that adhesiveness be clearly understood as different from what is termed "tackiness" in an ink or a varnish, and that it is really what is known as cohesion. What is really desired is the property called "body," which carries with it the cohesion which, acting with capillarity, gives to a lubricant the power of remaining between two surfaces subjected to pressure.

This whole subject is one which can only be considered broadly unless a specific instance is taken, but when the conditions of area, temperature, pressure, and speed are given, may be examined in detail. It is manifestly impossible to indicate the comparative value of various lubricants unless the conditions under which they are to operate are fully known. Knowing the operative conditions, however, it is practicable to select the best lubricant for the purpose, thus enabling the maximum reduction in frictional resistance to be secured at a minimum cost.

REVIEW OF THE CONTINENTAL PRESS

Chinese Mining Concessions to Foreigners.

At this time, when the attention of the world is fixed on China, it may be of interest to glance at a list of some of the concessions for mining in that country which were granted to foreigners before the outbreak of the present troubles. According to Herr Paul Speier, who writes in a recent issue of *Glückauf,* the principal concessions were the following:

1. That to the Peking Syndicate—an English company—for coal and iron mining in the provinces of Shansi and Hunan. The company agreed to pay 5 per cent. of the gross earnings to the Chinese government, and also 25 per cent. of that part of the net earnings remaining after providing for a 6 per cent. dividend to the stockholders, and for an annual sinking fund payment amounting to 10 per cent. of the capital. The concession covers enormous beds of anthracite coal, but in the two years since the grant was made, nothing has been done to develop the property except the geological surveying work of the engineering staff.

2. A German company has been granted a provisional concession for mining in four districts of Shan Tung, where the principal mineral wealth consists of coal.

3. The Manchu governor in Urga, North Mongolia, was appointed director of mines for a large territory which stretches along the Siberian border, and the mining rights there were granted to a Russian who had been an official of the Chinese government. A Russo-French company was formed with a capital of 3.000,000 rubles, a staff of American engineers was engaged and the work is in full operation—or was before the recent troubles began. Gold is said to be the principal product, of which 30 per cent. is paid to the Chinese government and 20 per cent. to the Mongolian magistrates.

4. A concession has been granted to a French company for obtaining quicksilver in the province of Kwaichau.

5. Another French company has obtained mining rights in some districts of Sze-Chuen. The conditions are unknown, but the work has begun.

6. Still another mining concession has been given to a French company in several districts of Yunan, the conditions attached to which are not known.

7. The Chinese Eastern Railway, a Russian enterprise, has mining rights for a distance of five miles on either side of its line.

8. Similar privileges have been granted to the Hankow-Canton Railway, an American undertaking.

Besides these strictly foreign concessions may be mentioned a couple of mining enterprises in which the capital is Chinese, but the engineering management is foreign. Such a condition exists in the province of Chi-li, where the viceroy, Chang Yen Mow, began mining on a systematic plan with the assistance of Herr Georg Detring, who, as commissioner of indirect taxes, has been a constant adviser of the Chinese government. A staff of ten engineers has been occupied in preliminary surveying and practical mining operations, and the capital for the undertaking has been exclusively Chinese. At thirty or forty places in the province, gold, silver and coal mines are worked by modern methods. This mining organisation, the only really profitable one, has a yearly product amounting to 800,000 taels, thanks to the activity of Herr Detring.

In the province of Sze-Chuen, Li Tai Ching, as director of a similar syndicate, has begun negotiations with an Anglo-Belgian company, and it appears likely that in the future the Chinese will enter into business relations with foreigners on the basis of this system.

American Competition in Germany.

A great deal has been said and written about American competition in engineering work abroad, and the subject has been pretty thoroughly discussed, in so far as it relates to England, in a notable series of articles in *Engineering*. But it is of never-failing interest to try to "see ourselves as others see us," and so it may not be amiss to make a few extracts from an address by Herr Unger before the Verein Deutscher Maschinen-Ingenieure, as reported in a recent issue of *Glaser's Annalen*.

The address is entitled "Has the German Machine Industry Anything to Learn from the American?" and after mentioning some of the British experience with American competition, the author goes on to speak particularly of the superiority of American machine tools and the causes therefor.

Statistics show that the importation of American machines into Germany is continually increasing, and if the newest and largest factories about Berlin are inspected, it is found that they are very well provided with American machine tools, this being notably the case at the Ludwig Loewe establishment, the Borsig engine works, the Allgemeine Elektricitäts Gesellschaft's plant, and in other places. Many business houses are occupied solely, and very successfully, with the sale of American machines. Now if all this is possible when German mechanical engineering is doing its utmost, the superiority of the Americans in several lines, particularly in machine tools, must be evident, and the question contained in the title of the address becomes very pertinent.

It is self evident that foreign products will find a sale only when they are cheaper than the domestic, or when they better fulfil the purposes for which they are intended.

It is hard to understand, off hand, how it is possible for America to manufacture so cheaply that its machines can compete successfully in Germany with those made there. The circumstance that the American manufacturer, protected by a very high tariff, makes such big profits at home that he is able to sell at lower prices abroad, does not offer a sufficient explanation. The lower cost of material at the place of production in America is also not decisive, for the American must either bring the raw material from a great distance to his factory, or must transport the finished product a long way to the coast. The ocean must then be crossed and the German duties paid, so that the transportation charges on the smaller and medium-sized American machines amount to 8 or 10 per cent. of their value, and to even more on large machines. Moreover, the wages in America are higher than in any other country. When, in spite of all these difficulties, American machines undersell the German, there can be only one explanation, which is that the Americans work with better and more perfect methods than do the Germans, methods by which the cost of production is reduced to the lowest point. If Germany wishes to retain its mechanical industries, it must learn those methods.

Herr Unger then reviews some of the points in American methods. He finds that automatic machinery is very highly developed in America. One workman can often tend half a dozen machines. While this saves an enormous labour cost on one hand, on the other it assures to the really able workman such high wages as are not dreamed of in Germany. The prospect of high wages, and the further prospect of winning his way to a leading position in a short time, excites the ambition of the American workman, whether he be a native or a foreigner, and he devotes all his brains and energy to improving and simplifying his methods of production. In this he is encouraged by his employer, who is always ready to discard antiquated methods and machines in favor of better ones. Wherever it is feasible, machines are used instead of hand work, and this is done to an extent which seems strange to a German.

A machine is used for only one kind of work, and, if possible, for a single purpose. It turns out a special product in great quantities. This specialisation and production in quantity form the basis of the extraordinary efficiency of American factories and their competitive strength when opposed to Old World methods.

In America some of the largest and most completely equipped works produce only two or three kinds of machines, and sometimes only one kind, and seldom have their own foundry, as this is looked upon as another specialty. In Germany, on the contrary, the medium-sized and smaller works take particular pride in "making everything."

The American manufacturer is far more

favourably situated. He is complete master of his comparatively narrow field; he is thoroughly up-to-date, and so does not allow himself to be dictated to by his customers. His machines are standardised and a stock is kept on hand, so that orders can be immediately filled. Production is systematised and there is a thorough division of labour. Each tool performs a definite operation, and then passes the piece on to the next tool. The parts are submitted to a rigid inspection as they pass from tool to tool, so that at last, when they are assembled, there are almost no corrections to be made.

These are the general reasons for the cheapness of American machines. That they are also of good and suitable construction is natural from the specialisation and sharp competition in America, and is evidenced by their employment in some of the leading German establishments, where mere cheapness would not win a way for them.

Herr Unger believes that the Germans will have to adopt American methods and tools of American pattern in order to compete successfully with Americans, and he gives various examples of this tendency in German mechanical industries.

Test of a Parsons Steam Turbine.

We are accustomed to associate Parsons steam turbines with high-speed torpedo boats, and to pay comparatively little regard to their activity in other fields; but some recent tests of a turbine designed to drive a 1,000-kilowatt rotary-current dynamo compel more than passing attention. This turbine is one of a pair ordered by the city of Elberfeld for its new central station, and combined with a rotary-current machine, an exciting dynamo, a condenser, and air-pump apparatus forms a generating unit.

At a speed of 1,500 revolutions per minute, at 4,000 volts and 50 periods per second, the dynamo is to deliver 1,000 kilowatts when the cosine of the angle measuring the difference in phase between electromotive force and current is 0.8. The turbine contains two groups of guide blades and wheel blades, the first group high-pressure and the second low-pressure, through which the steam passes in turn. The air pump is run by worm gearing at one-eighth the speed of the turbine. The dynamo is directly coupled to the turbine, and carries the exciting-current machine on the outer end of its shaft.

Before these machines were accepted by Elberfeld, a very thorough test of one of the sets of machines was made on behalf of the city by three experts—W. H. Lindlay and Professors M. Schröter and H. F. Weber. The turbine and dynamo, with all the auxiliary machinery and connections, were erected at the Parsons works, and tests under various conditions and with different loads were carried out with elaborate precautions. The inductionless load consisted of a water resistance in four iron tanks, each corresponding to one-quarter of the load. The bottom and sides of each tank formed one electrode, while the other dipped into the water and could be raised and lowered, thus varying the resistance, so that the load could be easily adjusted. The inductive resistance, when used, consisted of a large coil, the interior of which was partly filled with iron plates whose amount could be varied until the desired difference of phase was obtained.

The results of the tests are given in full by the *Zeitschrift des Vereines Deutscher Ingenieure,* from which some figures are here abstracted. The first series of experiments was made to determine the steam consumption under different loads. As the steam pressure and the degree of superheating varied during the tests, the amount of steam per kilowatt-hour was calculated from the observed results for an average pressure of 11 atmospheres, absolute (162 pounds per square inch), and 14.3 degrees of superheating, with the following results:

Dynamo load in kilowatts		Pounds of steam per kilowatt-hour
1190.1	(overload)	19.3
994.8	(full load)	20.1
745.3	(¾ load)	22.2
498.7	(½ load)	25.4
246.5	(¼ load)	33.8

When running with no load, with the field magnets of the dynamo excited, the turbine used 4,057 pounds of steam per hour; and when the field magnets were not excited, the consumption of steam was 2,604 pounds per hour.

The steam consumption for loads of one-half the normal and upwards more than satisfied the contract requirements, and though the figures for one-quarter load and no load were not quite so good, this is partly accounted for by the fact that the contract specified steam with 50 degrees of superheating, while that actually used in the tests was superheated, on the average, only 14.3 degrees. At any rate, any possible deficiency at the very light loads is more than made up by the excess at the heavier ones, particularly as the turbine will generally be run with high loads, and very seldom with less than one-third of the normal, and the results of the tests as to the useful work done and steam consumed may be regarded as eminently satisfactory.

The turbine itself, at a steam pressure of 11 atmospheres, absolute, delivered from 1,300 to 1,400 kilowatts (1,740 to 1,870 horse-power).

The contract specified that with a gradual change from no load to full load and vice versa, the speed should not vary more than 4 per cent. The variation determined by experiment was only 3.6 per cent.

With sudden changes of 25 per cent. in the load, the centrifugal governor was to hold the speed variation within 0.8 per cent. In the tests the loads underwent sudden changes of from 16 to 63 per cent., and the resulting speed variations immediately after the changes ran from 1 to 1.9 per cent., and then settled down to from 0.4 to 1.3 per cent.

With the electrical governor and sudden changes in load of from 12 to 62 per cent., the average variation in electromotive force was 1.1 per cent., whereas the contract specified 1 per cent. with 25 per cent. change of load.

When the magnitude and suddenness of the changes made in the experiments are considered, the observed results more than satisfy all reasonable requirements.

The drop in voltage when increasing the load from nothing to full inductionless load, the speed and excitation remaining constant meanwhile, was not to exceed 6 per cent. The actual drop was only 1.02 per cent.

With an inductive load, the other conditions remaining the same, the drop was 11 per cent., which may be regarded as a favourable showing.

After a run of six hours, the rise in temperature of any part of the generator or exciter was not to exceed 40° C. This figure was overstepped only in the core of the generator armature, where the temperature rose 48.5° C, but this slight fault will be remedied by the builders, who will increase the ventilation of the armature.

The Bremer Arc Lamp.

In the two decades during which the electric arc-light has been a commercial reality, it has made no startling progress. It is true that the regulating mechanism has grown better and more even in its action, the life of the carbons has lengthened, particularly since the introduction of the enclosed arc, lamps are run on low tension circuits and other improvements in detail have been made, but the efficiency of the light has increased hardly at all, and its colour is still the bluish-violet that it always has been.

The small progress made by the electric light in comparison with the incandescent gas light, employing the Welsbach mantle and similar devices, has enabled the latter to become a dangerous rival to electric illumination, and although there are great inherent advantages in the electric light, it must be made more efficient and cheaper if it is to drive its competitor from the field.

There have been many attempts at treating arc-light carbons by impregnation and in other ways, which have had the effect of making the arc burn more quietly and imparting a somewhat better colour to the light, but no striking results have heretofore been achieved.

But according to some tests made by Herr W. Wedding, whose experiments are recorded in the *Elektrotechnische Zeitschrift,* a decided advance has now been made by Herr Bremer, who prepares carbons containing from 20 to 50 per cent. of non-conducting salts of metals, such as calcium, silicon and magnesium.

The first measurements made were of a continuous-current arc lamp taking about 12 ampères. The positive carbon was the only one specially treated and it contained a calcium compound. In the article just mentioned are given tables and curves of illumination at various angles with the horizontal, from which it appears that when no globe was used, the mean hemispherical intensity of the light was 4,320 candles. The average current through the lamp during the run was 12.3 ampères, the mean electro motive force 44.4 volts, so that the average power used was 546 watts, or 0.126 watt per candle.

The same lamp with a globe had a hemispherical intensity of 2,772 candles and used 543 watts, or 0.196 watt per candle.

The second lamp tested is similar to one now hung on the Eiffel Tower, in Paris, at an elevation of 95 meters. It has four arcs, takes about 60 ampères of continuous current, and the positive carbons contain a calcium compound, as before. On account of the great intensity of the light the tests had to be conducted at night and in the open air. The lamp was hung 8 meters above the ground, and the illumination was measured on a surface 1 meter from the ground and at different distances from the lamp. From the observed results it was found that the maximum intensity of the light when no globe was used was 83,000 candles, at an angle of 37 degrees below the horizontal, while the mean hemispherical intensity was 49,730 candles. The average current was 55.8 ampères, the electromotive force 89.3 volts, so that the power used was 4,980 watts, or only 0.1 watt per candle. When covered with a globe, the hemispherical intensity of the light was found to be 26,890 candles, and the power used 4,610 watts, or 0.17 watt per candle. From the above figures, it appears that for the arc lights without globes the power used was hardly more than 0.1 watt per candle. Herr Wedding states that the lowest power consumption he had ever found with other kinds of lamps was 0.3 watt per candle, and that the average was between 0.4 and 0.5 watt. The new lamp, therefore, is three times as efficient as the best of the old ones, or, putting it another way, with the same power three times as much light is produced.

An alternating-current arc lamp with one of its carbons treated by the Bremer process was measured without a globe and found to have a mean intensity of 512 candles and to use 0.5 watt per candle. This shows a decided improvement on previous alternating-current arc lamps, and it is believed that with better construction even more favourable results can be obtained.

The regulating mechanism, which works smoothly, is much simpler than in the ordinary kinds of lamps, but the details are not yet ready for disclosure. In the ordinary lamps most of the illumination comes from the glowing carbons, but in the new lamp the arc itself furnishes considerable light, and so makes a more even distribution of illumination. Above the arc and surrounding the upper carbon is a conical tin hood, which helps to retain the heat generated in the arc and also acts as a reflector. Some of the products of combustion settle on the inner surface of this hood in the form of a pure white powder which makes an admirable reflecting surface and helps in the even distribution of light, so that the lamp globe, when on, appears uniformly illuminated and the upper half is not in the shade, nor are sharp shadows of the negative carbon and its holder cast on the lower hemisphere.

Favourable photometric measurements alone do not make a lamp successful. Much depends upon the æsthetic impression which the light makes on the eye, and in this respect the new lamp is not wanting. The large amount of calcium contained in the carbon gives rise to a rich yellow-red radiation, in contrast with the usual bluish-violet rays of the arc, so that the light has a much warmer tone. According to the inventor, the colour of the light can be regulated at will by varying the composition of the carbons.

The richness in red rays of the Bremer lamp led Herr Wedding to try some experiments to determine how well it could penetrate fog and mist. He took a lamp of the ordinary kind and a Bremer lamp and interposed a cloud of steam about 1 meter thick between them and a photometer. Repeated observations showed that the penetration of the new light was twice as great as that of the old. This result points to the applicability of the Bremer lamp to lighthouses and signal lights where the penetration of fog is of consequence.

A Steel-Pipe Bridge.

THE Société Electro-Métallurgique Française is engaged in the production of aluminium, pure and in the form of alloys, of silicon, of carbide of calcium, and so on. It has four large plants, one of which is situated at La Praz, on the line of the Mont

Cenis Railway, in the department of Savoy. The La Praz works are situated on the bank of the Arc river, from which power is obtained. The water is led to the plant by means of two steel conduits, one of which is 1,200 meters long and 2 meters in diameter, and the other 1,000 meters in length, with a diameter of 2.4 meters. The former, or low-pressure conduit, gives a head of 33 meters, the latter, the high-pressure one, delivers the water with a head of 72 meters. At the generating station are turbines with a total horse-power of about 12,500, running twenty-eight continuous-current dynamos and alternators of various sizes.

Perhaps the most remarkable part of the plant is the high-pressure conduit already mentioned, both from the fact that it transmits 10,000 horse-power and because of the way in which it crosses the Arc river. Its diameter is 2.4 meters (7 ft. 10.5 in.) from the intake to the pen-stock; the diameter of the latter decreases from 2.4 to 1.8 meters. The speed of the water in the conduit is about 2.75 meters per second. The steel plates of which the pipe is constructed have a thickness varying from 5 millimeters at the intake to 15 millimeters at the pen-stock, though a few sections at the springings of the arch across the river are 16 millimeters thick. The pipe has no expansion joints, the curves which occur in the course of its length taking up any expansion. For the most part it is laid right on the ground or in shallow trenches, but in a few places, in order to avoid too sharp curves, it is carried above the ground on masonry columns. The total weight of the pipe is about 785,000 kilograms (400 tons).

At one place the conduit had to cross the river, and it was decided to carry it over in the form of a flat arch, with a clear span of 50 meters. The arch was erected on staging placed in the bed of the stream and was built out from both abutments until the parts met at the key-ring. The sections of pipe practically imbedded in the abutments have circular and longitudinal flanges in order to prevent any displacement. The abutments themselves are of concrete, reinforced by bands of iron.

Besides carrying its own weight and that of the water flowing through it, the tubular arch supports a foot-way with railways, and, according to M. A. Lapouche, from whose article in the *Génie Civil* this account is taken, the structure has proved to be a happy solution of the problem involved.

The Elbe-Trave Canal.

Some years ago it was thought that canals had outlived their usefulness and that they could no longer successfully compete with railroads. But more recently there has been a change of sentiment, as is evidenced, among other ways, by various plans for the improvement of the Erie Canal and by proposals for canals to connect the Mississippi Valley with the Great Lakes. In Germany the renewed interest in canals has been particularly great. Not to mention the great Kiel ship canal, connecting the Baltic with the North Sea, which is primarily a strategical work, there is now under construction, or proposed, a system of commercial canals connecting all parts of the interior of the Empire.

One of the links of this system is the Elbe-Trave canal, which was formally opened in June. This canal runs from Lauenburg, on the Elbe, to the old Hansa city of Lübeck, on the Trave, which flows into the Baltic, and is of special importance to the latter city, which thus secures an adequate water connection with all that part of Germany reached by the Elbe, its tributaries and its canal system. A canal between the Elbe and the Trave, the so-called Stecknitz Canal, has existed since the end of the fourteenth century, but though it formed the main artery of trade from the Elbe through Lübeck to the Baltic region for a couple of centuries, its usefulness afterwards decreased, and latterly it has been entirely inadequate for the demands of modern commerce.

Plans for its improvement or for a new canal between its terminal points have been proposed from time to time, but have met with many obstacles, partly owing to the fact that the line runs through, or adjacent to, the territory of four different States—Prussia, Lübeck, Mecklenburg-Schwerin, and Mecklenburg-Strelitz. But finally all the preliminary difficulties were overcome, a plan was settled on, and work was begun about five years ago.

The canal, according to the *Zeitschrift des Vereines Deutscher Ingenieure,* is 67 kilometers (42 miles) long. The distance from Lübeck to the summit level is about 26 kilometers. There are five locks on this section with a total lift of about 12 meters (39 feet), the elevation of the summit level above the sea. The summit level is 30 kilometers long, and the canal then runs to the Elbe at Lauenburg, a distance of 11 kilometers. There are two locks on this section, the descent from the summit to the Elbe varying from about 7 to 8 meters. The present bottom width of the canal is 22 meters and the depth of water 2 meters, and it is purposed to increase these dimensions to 27.3 meters and 2.5 meters, respectively. The western bank has been permanently finished, but the eastern bank has been only temporarily built, in order to allow for the enlargement. The tow paths are 2 meters above the water level; the eastern one is 2 meters wide and the western or principal one 3.5 meters. On the latter a system of electric haulage will be provided later.

The locks are 80 meters long and 17 meters wide, with gates 12 meters wide and have 2.5 meters of water on the sills. They are built on the Hotopp plan, and are filled and emptied and have the gates operated by a hydraulic and pneumatic system. The largest boats which run on the canal are the Elbe barges, 78 meters long and 11.5 meters wide, with a capacity, when drawing 1.75 meters (5.75 feet), of 1,000 tons.

The cost of the canal was 23,554,000 marks, of which 7,500,000 marks were contributed by Prussia and the rest by Lübeck. The operating and maintenance charges will be borne by the two States in the same proportion as the first cost was.

German Central Station Statistics.

ACCORDING to its annual custom the *Elektrotechnische Zeitschrift* has recently published tables showing the condition of the central stations in Germany on March 1, 1900, with editorial comments thereon. These tables cover, as far as possible, all central stations which publicly furnish current for lighting and power purposes, but do not include private plants or generating stations which supply current exclusively for railway work. Stations which furnish current for both lighting and railway operation are, however, included, and are properly designated in the tables. The columns of the principal table give the name of the station and its owners, the place where it is situated and the number of inhabitants thereof, the system used—whether continuous-current or alternating-current, or some other—the motive power, the capacity of the generators, the capacity of the secondary batteries, where used, the number of incandescent lamps connected, the number of arc lamps, the horse-power of the electric motors operated, the number of meters, the date of opening, and remarks, which often give the electromotive force used.

According to the reports sent in to the *Elektrotechnische Zeitschrift,* there were in Germany, on March 1, 1900, 652 electric central stations, contrasted with 489 on the same date last year, or an increase of 163. There were 122 in course of construction, 17 of which were to be finished by July 1, at which time the number completed thus amounted to 669. This figure is probably below the actual total, as no answer was returned to some of the requests for information sent out to central stations. Of all the stations in operation on March 1, 625 were built in the last decade, and only 27 were in existence before the end of 1889.

The number of central stations differs of course from the number of communities lighted by electricity, for on the one hand there are cities which have several electrical works, and on the other, it sometimes happens that one station supplies current to a number of towns and villages. In this latter respect there lies one distinct advantage of electric over gas lighting, for while the latter is confined to a comparatively limited area surrounding the gas works, the electric current can be led to considerable distances with little loss and at small expense, and can be conveniently distributed from a single central station to many places which could not support a gas works. In some cases as many as 30 communities are lighted from one central station. Although the number of electric stations does not yet quite equal the number of gas works in Germany, the communities supplied with current for electric lighting are even now more numerous than those provided with gas, there being about 900 of the former to 850 of the latter.

The tables show that 80.4 per cent. of all the central stations supplied continuous current only, but that the capacity of their dynamos is only 47.4 per cent., and the combined capacity of their dynamos and accumulator batteries only 53.8 per cent. of the total output of all stations. The percentage of continuous-current stations to the whole number remains about the same as last year, while their proportionate capacity has fallen off somewhat. The continuous current, however, has not yet lost its commanding position in Germany. A closer inspection of the statistics shows that while the absolute number and capacity of continuous-current works has increased decidedly, the corresponding figures for the alternating and polyphase stations show only a slight enlargement. There is, though, a very great increase in those works which supply both continuous and polyphase currents, or in which the primary polyphase current is transformed into continuous.

Almost all (93.1 per cent.) of the continuous-current stations have storage batteries, a slight increase over last year. The storage-battery capacity of these stations is 37.9 per cent. of their dynamo output, and is 20 per cent. of the dynamo capacity of all kinds of central stations.

The number of single and two-phase alternating-current stations has increased during the past year from 33 to 42, and their capacity from 17,826 to 21,573 kilowatts. There are now 39 works furnishing polyphase current exclusively, as compared with 33 last year, and their capacity has risen from 29,715 to 35,150 kilowatts, or 18.39 per cent., whereas in the previous year the gain was 109 per cent. Besides these exclusively polyphase works, however, there are at present 38 combined polyphase and continuous-current stations, against 22 last year, their capacity now being 46,608 kilowatts as compared with 25,970 last year. The number of combined alternating and continuous-current stations has changed from 5 to 6, and their capacity risen from 1,011 to 1,700 kilowatts. In two works, with a combined capacity of 790 kilowatts, current is supplied by monocyclic generators.

It is but natural that steam should be the principal motive power, as there is a lack of available water power in Germany. The stations operated entirely by steam are 382, or 58.6 per cent. of all, and their capacity is 146,624 kilowatts, or 76.5 per cent of the total, just about the same proportion as last year, when the percentages were 59.9 and 76.5, respectively. The number of works run by water power is 74, or 11.4 per cent., as against 11 per cent. last year, while their capacity is 15,674, or 8.2 per cent. of the total, compared with 10 per cent. in 1899. When it is considered that among these water-power stations is counted the largest electrical plant in Germany, the power-transmission works at Rheinfelden, with an output of 12,000 kilowatts, and that therefore the remaining 73 water-power stations have a combined capacity of only 3,674 kilowatts, it can be seen that, in general, only very small plants are driven exclusively by water. As a rule, those stations which have water power have steam power besides. There are 144 of such works, with a capacity of 26,674 kilowatts, the corresponding figures for 1899 being 103 and 17,201, respectively. In many cases, however, either the water or steam power is used only as a reserve. Although the number of stations driven by gas shows a not inconsiderable increase from year to year, having risen in the past twelve months from 21 to 29, their capacity, 1,881 kilowatts, is not yet as much as 1 per cent. of the total. Gas engines, however, are used as a reserve in some of the smaller steam and water-power stations.

One of the tables groups the stations according to their capacity. From this it appears that 306 plants have a capacity, including dynamos and accumulators, of 100 kilowatts and under; 249 are between 101 and 500 kilowatts; 31 between 501 and 1,000; 29 between 1,001 and 2,000; 17 between 2,001 and 5,000; and 6 are over 5,000 kilowatts. The capacity of 14 of the stations on the list is not known. The 23 largest works, including the one at Rheinfelden, have a combined capacity of nearly 100,000 kilowatts, or 43.1 per cent. of the total. In some of these twenty-three, however, part of the current is used on street railways, and at the Rheinfelden works nearly three-quarters of the energy is employed for electrolytic purposes.

The points cited in this review are only a few of the many interesting ones brought out in the tables, to which the reader is referred for details.

REVIEW OF THE AMERICAN PRESS

Topography of the Nicaragua Route.

A VERY important contribution to the literature of the isthmian canal is supplied by *Engineering News* in the form of a condensation, by Mr. E. S. Wheeler, C. E., chief engineer of the Nicaragua-canal commission of 1897-1899, of the report of that commission. The result of their work has been so inaccessible that this brief presentation, even without the data, discussion, or recommendation, is most welcome.

Mr. Wheeler at the outset makes very plain the general topography of the region, which is "geologically recent and therefore very clear." There are three principal mountain ranges. Farthest to the north lie the Nicaraguan highlands, having peaks 5,000 to 7,000 feet in height; farthest south are the Costa Rican mountains, rising to 11,000 feet. These two ranges "overlap each other for about a hundred miles, their crest lines being parallel to each other and about seventy miles apart. Between them lie the San Juan valley and river," extending from Lake Nicaragua in a southeasterly direction to the Caribbean Sea. This valley is about eighty miles long, about twenty-five miles wide between the foot hills, with a floor rising gradually from the Caribbean Sea to an elevation of 200 feet at Castillo, and thence declining gently to about 100 feet at the lake. Transversely, it rises toward the foot hills at the rate of about four feet to the mile. Through the Castillo crest the San Juan river has cut its way, in a gorge which in its central part is more than 100 feet deep. Any canal having its lake for its summit level must pass through this gorge, or make an artificial cut 50 miles in length and with depths exceeding 100 feet, which is, of course, out of the question. "The area in which a canal is feasible is thus confined to very narrow limits and the problem of location is greatly simplified." The difficulties to be met in this point are those attendant on the canalization of the San Juan, especially the location of dams and the control of the flood waters of the San Juan and San Carlos. In this stretch Mr. Wheeler proposes three dams—at Machuca, Conchuda, and Boca San Carlos—in place of the one huge Ochoa dam proposed by Mr. Menocal. At each dam would be a lock with a lift of about 18 feet, the uppermost one varying from 18 to 24 feet with the varying level of the lake. Below the gorge and thence to the Caribbean Sea, the San Juan valley is filled by the flood plain of the river, merging insensibly into the delta. It has a slope of 1½ feet to the mile, is covered during the wet season with several feet of water, and consists in the upper part of yellow clay, with a shore belt of black sand sometimes two or three miles in width. The entire plain is very uniform, four different canal routes run across it showing almost the same estimated cost per mile in every case. Canalization of the San Juan below this point is impossible on account of its great volume and heavy burden of detritus, and "the great depth to suitable foundations for dams." The problems here are the crossing of the tributary valleys (minimized by locating the canal in the narrow plain between the river and the Nicaraguan hills), the location of the locks, and the construction of a harbor in a delta which is pushing seaward at the rate of 75 feet a year. Three locks are to be placed in this section. Mr. Wheeler makes no comment upon their location, nor upon the possible difficulty of finding foundations in the delta-plain. He says of the entire location: "It is believed to be very nearly as good as any that can be made * * * more minute surveys may make minor changes. * * * but it is not believed that any changes can be made that will diminish (the cost) as much as 10 per cent."

So much in brief for the eastern slope. Mr. Wheeler lays emphasis upon the point that the San Juan valley, in which this eastern stretch of the proposed canal lies, "is not a break or low pass through a mountain range, but a region or valley lying between the distinct and widely-different mountain ranges." At one time this valley extended through from ocean to ocean. What is now the enclosed and elevated basin of Lake Nicaragua was an ocean bay, lying behind a long point formed by the northwesterly end of the Costa Rican mountains. The West Coast volcanoes—the third principal mountain group referred to at the outset by Mr. Wheeler—broke out in the sea, substantially midway between the parallel ranges of the Nicaraguan highlands and the Costa Rican mountains, and extending across from one to the other, shut in the valley between them at its northwestern end, enclosing Lakes Managua and Nicaragua. At that time the discharge of Lake Nicaragua was westward into the Pacific, and so continued long enough to wear down in the solid rock a gorge 20 to 40 feet deep and 3 to 4 miles long. The clays of the eastern ridge, however, wore away still faster; streams flowing westward into the lake from about Castillo worked down through the low ridge of the divide, and the outlet of the lake was turned eastward, with resultant lowering to a level 50 feet below its former westward outlet. To the Pacific, therefore, there is no outflowing stream which can be canalized. The valleys of the Lajas, rising from the lake to the divide, and of the Rio Grande, falling from the divide to the Pacific, are, however, "so much lower than any other pass between Lake Nicaragua and the Pacific that they alone need be considered in connection with a canal." A rock-cut of 10 miles to Buen Retiro (reversing the flow of the Lajas) would extend the summit-level to that point. Four locks in the 7 miles of canal between this point and the ocean would lower the canal the entire distance on the western side. The key problem may best be summed up in Mr. Wheeler's words: "From the preceding the reasons for the final choice of location will be readily understood. It has been shown that the canal location on the west side must be in the valley of the Rio Grande and Las Lajas, and on the east side, between Lake Nicaragua and the San Carlos, it must be in the gorge of the San Juan.

"The first and most important question to be answered is, whether or not the gorge of the San Juan can be utilized for a canal with the river San Juan still flowing through it, and it is one that has never been adequately discussed.

"The reason for this seems to be that the early canal engineers assumed the maximum flow in the San Juan, where it leaves Lake Nicaragua, to be 18,000 cu. ft. of water per second, and not very much increased by its tributaries until it reached the San Carlos." Such a discharge as this would make a maximum velocity less than 2 ft. per second, which would not interfere with the safe passage of ships; therefore it was considered that the gorge could be used for canal and river simultaneously.

The Canal Board of 1895 was the first to point out that this maximum flow was greatly underestimated.

"The results obtained by the commission of 1897-99 show that the discharge from Lake Nicaragua often reaches 50,000 cu. ft. per second. The drainage into the San Juan above the San Carlos also reaches 50,000 cu. ft. per second, so that the discharge of the San Juan above the San Carlos often reaches 100,000 cu. ft. per second, and there is conclusive evidence that floods greater than this have occurred.

"It was also found that such floods would make a velocity in portions of the canalized river of more than 6 ft. per second. It is believed this would make navigation impossible for the time being and would also erode the banks and fill up the artificial channels, so that the canal would not be usable after the subsidence of the flood until portions were re-excavated.

"If such floods are uncontrollable the gorge of the upper San Juan cannot be used for a canal. With a flow of only 18,000 cu. ft. the river could be canalized, but with 100,000 it cannot. The means for controlling these floods are three: (1) By dams and wasteways in the San Juan river, which will temporarily retain the water in Lake Nicaragua and allow it to flow out at a limited rate; (2) by enlarging the cross-section in the San Juan river until its flood velocity ceases to be injurious; (3) by the creation of a new wasteway on the Pacific side, and thus withdrawing the larger portion of the flood from the San Juan river.

"Any one of these methods, if employed alone, would involve a cost that would be practically prohibitive. The minimum cost is found by a judicious combination of the three. * * * With these conditions it is found possible to reduce the maximum flow in any part of the San Juan to less than 30,000 cu. ft. per second, with a velocity less than 2 ft. per second, which it is believed will not seriously impede navigation or erode the channel banks. The question, therefore, as to whether the gorge of the upper San Juan can be used for a canal with these conditions may be answered in the affirmative."

The estimate based on this project, including harbors sufficient "for canal purposes only," is a little in excess of $130,000,000. Mr. Wheeler points out in conclusion that the opinions given and methods proposed are those of the chief engineer, which do not in all cases coincide with those of the commission.

"The commission proposes (1) a single high dam in the San Juan river instead of three low ones; (2) to permit 85,000 cu. ft. of water per second to flow through the canalized portions of the San Juan instead of limiting it to 25,000; (3) to limit the flow westward to the Pacific to 15,000 cu. ft. per second instead of increasing the capacity of the wasteway to 35,000 cu. ft. per second. In addition to these points of difference, the unit prices here given and the methods of obtaining them are not fully approved by the commission."

On the whole, it is scarcely an enthusiastic argument for the Nicaragua canal. The difficulties of canalizing the San Juan, and of dealing with the volumes of sand brought down to the Caribbean Sea are perhaps thrown into clearer relief than they have ever been before. Mr. Wheeler's paper adds keenness to the interest with which the report of the latest commission is awaited.

Communication with the Orient.

WHILE not properly to be classed as an engineering periodical, the *North American Review* offers two articles, both dealing with important phases of the far-eastern question which is so engrossing at present, and both closely concerned with engineering development.

The first, by Mr. Eugene T. Chamberlain, U. S. Commissioner of Navigation, entitled "Ocean Transportation to Eastern Asia," is an exhortation to the marine interests of the United States to awaken to their opportunities before other maritime nations have seized upon them. The advantages of access lie with the American Pacific ports. Hong Kong is 7,903 sea miles from Marseilles, and but 6,086 from San Francisco; Manila is 7,906 miles from Marseilles and but 6,254 from San Francisco; from Shanghai to Marseilles is 8,758 miles, to San Francisco but 5,550; between Yokohama and San Francisco the distance is but 4,564 miles, against 9,476 miles from Yokohama to Marseilles. The Suez canal routes from Europe also impose a toll, amounting in the average to one dollar per ton of cargo, going and coming, for a full-laden ship. Against this must be set the coaling opportunities of the Suez canal route; a Trans-Pacific steamer must carry coal for the full voyage, at the expense of cargo room; Europe further "enjoys the advantages of cheaper ships and lower cost of operation for its merchant ships." But with the increase of the size of ships and of the economy of coal consumption, and with large and fast steamships on the Pacific, "the United States have the advantage of nations which must use the Suez canal."

Mr. Chamberlain, however, deplores the slowness of his country to see and avail itself of its opportunity, and the comparative enterprise of other nations. "The German Cabinet report which announced to the Reichstag the purchase of the Carolines and the Ladrones (except Guam) was accompanied by a chart showing the new lines by which the North German Lloyd Steamship Company proposed to bind these islands, whose purchase at that time had not been ratified, to other German possessions in Asia." "Japan * * * for some time has had in operation to the United States 17-knot steamships of 6,000 gross tons, the largest and fastest vessels now employed on the Pacific Ocean." "Europe has been preparing * * * for the competition for several years."

He points out the increasing deficiency of tonnage on the Pacific, and asks: "Is this lack of tonnage to be supplied by American vessels, or do we purpose at the outset voluntarily to abandon the carrying trade of the Pacific to our foreign rivals, who have already acquired control of the Trans-Atlantic trade?"

"The ocean-carrying trade of a nation," Mr. Chamberlain concludes, "is as much a national industry as any manufacturing process." In the fatuous policy of "protecting American ship building" during the last thirty-five years, however, the United States have almost succeeded in destroying the vastly greater industry of sea carrying; 39 clearances out of 5,390 in the trade from the United States to Europe in 1899 were under the American flag. Now England, Germany, and Japan are taking the trade of the Pacific. How long will it take the United States to awaken?

Immediately following Mr. Chamberlain's article is one by Mr. Chandler Hale on "The Projected Cable Line to the Philippines," forcefully supporting the argument for a non-national line by the northern route which was so ably presented in these pages by Mr. Harrington Emerson in November last.

Mr. Hale points out first the roundabout line of communication which is now the only one open to the new possessions of the United States, and the imperative need for something better. The proposed southern route, however, would cost at least $21,000,000, and with a branch line from Guam to Japan, the cost would exceed $25,000,000. Japan, however, in Mr. Hale's view, would not permit a foreign government to land a cable on its shores; the branch line to capture the Japanese business, so essential from a commercial point of view, would, therefore, be impossible; a government line could not hope, either, to expect any business west of Manila, and would have to its credit in annual business only the saving of about $400,000 now expended yearly in official cabling to the Philippines and an additional $150,000 of (estimated) Hawaiian business. Against this yearly revenue of $550,000 would stand annual maintenance expense of more than $1,550,000. But for a guarantee of $400,000 yearly for transmission of government messages, "a sufficient number of responsible individuals and companies are willing and even anxious to secure the permission to establish this entire cable."

Turning then to the northern route, Mr. Hale shows, as Mr. Emerson did, its enormous advantages, in that it avoids great depths and great length of individual links. An international cable by this line would cost but $6,000,000. It would lie in latitudes all lower than that of Aberdeen, and in climates far superior to that of the North Atlantic. A single spare cable of 850 miles would replace any link. Repairs could be made at any time of year, and repair ships could find harbor within 120 miles of any break. Mr. Hale ends with a remarkable summation of the advantages of Dutch Harbor as a strategic point. "A map with concentric circles will show that Dutch Harbor is the great central port of the North Pacific, and that Hawaii is the most out-of-the-way place in the northern hemisphere."

A cable is essentially a commercial bond, and will be of infinitely more value to the world and to its owners if established on commercial lines than if undertaken in a spirit of militant nationalism.

German Iron Markets.

THE menace of prevalent conditions in the American iron trade has been lately pointed out in this magazine, and a remedy indicated. Both in the editorial prefacing Mr. Jean's article in our July issue, and in Mr. Hull's able paper in our August number, American iron-makers were exhorted to reduce prices as a measure tending to stability and protection against coming depression.

In the *United States Consular Reports* Mr. Frank H. Mason, Consul-General at Berlin, shows the curious correspondence which exists between German and American conditions, with, however, an equally striking distinction. In Germany, also, "railway and bridge building, and car, railway, and ship construction," all "have been restricted by the high cost of iron and steel," and "makers of hardware and many small articles of iron and steel have been compelled almost to suspend operations by the high cost of materials." And the very next statement is that "the period of highest activity in the metal industries has been reached, and although business is still brisk and many establishments filled with orders for some time to come, the average period of delivery has been reduced in some cases from six or eight months to as many weeks."

The *Berlin Boersen Courier* therefore advises the German producers of pig iron to "reduce their selling prices at once." "Iron masters' syndicates are now besought to gradually and steadily reduce the selling prices of their product to the lowest reasonable figure, and thus not only keep the home market in their own hands, but increase thereby the consumption of metals."

There is an argument and a threat in this; the appeal to "increase the consumption of metals" is addressed to the reason; the hint to "keep the home markets" is designed to work on the fears of the German iron-makers—and not without foundation. "The recent drop in the price of American iron and steel," says Consul-General Mason, "has produced a general feeling of apprehension among the iron-masters and holders of industrial securities in Germany and Great Britain." They "have clearly seen the day when, the stress of an abnormally active home demand being satisfied, the European markets would have to meet the attack of an American surplus, manufactured under every advantage of cheap, abundant materials, low freightage, and the highest, most effective substitution of machinery for human labor." Sales of 4,000 tons American pig iron at 73s. ($17.01) per ton delivered at Hamburg and the offer of a "large shipment" at 84 marks ($20) per ton c. i. f. Amsterdam made German furnace men think the hour of danger had come. There are prices with which German irons can still fairly well compete, but with cheaper ocean freights—which Mr. Mason thinks are certainly to be expected—what will be the situation? Germany's export trade of 180,000 tons—chiefly to Belgium—"is already as good as lost."

Mr. Mason's review of the situation suggests magnificent possibilities for the American iron-maker. He implies a belief that a still more far-sighted policy would dictate that the iron "should be worked up at home and only the ultimate finished products exported." The one weak point of the American position he considers to be "lack of tonnage under their own flag." We might add lack of stability in market conditions, and lack of attention to foreign markets, except spasmodically under the stress of extraordinary situations at home. Probably this last is even more important than the first. With a constant, intelligent campaign, there are certainly enormous possibilities for American iron and coal on the Continent. As the *Statist* puts it: "Over and above all, the shadow of America is towering over the market."

The Economy of Rapid Building.

The "sky-scraper" seems to have exerted a revolutionizing influence in building methods—and, indeed, in the way of looking at building operations and at buildings themselves—which is almost as remarkable as these tall structures are when regarded simply as elements of a city sky line. They are typical of the spirit of the age—the effort at the utmost attainable economy, and the larger possible output from a given plant. In this case the plant is the piece of ground to which modern city conditions have given extraordinary value as a rent-yielder. "The building is merely the machine which makes the land pay," says Mr. Cass Gilbert in the *Record and Guide* (our quotation is from a republication in the *Engineering Record*). "The more economical the machine, both in construction and operation, provided it fulfils the needs, the more profitable the land."

It is economy in construction, in so far as this is secured by rapid erection, which forms Mr. Gilbert's main theme. Taking the Broadway Chambers, New York, as a text, he puts the practical, financial aspects of the construction of a huge building of this sort in a new and striking light. This structure, 50 by 95 feet in plan and eighteen stories high, was contracted for on March 1, 1899, and was completed and occupied by tenants May 1, 1900. Old buildings on the site had to be torn down, neighboring buildings and streets supported, foundations put in, materials prepared and assembled, and the construction itself completed within this time. Much trouble was experienced under the second head, and it was October 1 before the steel columns for the basement were set. By Dec. 7 seventeen stories of steel were in place and the frame was completed Dec. 31. Feb. 1, masonry was completed to the cornice and glass was in place for fifteen stories. On April 27 tenants began to move in. But, as Mr. Gilbert says in summing up:

"Rapid construction is not undertaken merely for the purpose of making a record. It is a necessity arising from economic conditions. The value of land is an important item in construction. Many an owner hesitates to tear down an old building and encounter the expense of a new one, when he realizes that in the process of the change he will, probably, lose from one to two years' rent, thus losing the interest on the money already invested in the land. To minimize this loss, then, becomes a most important factor in the financial scheme of the enterprise. Assuming, for instance, that the value of the land upon which the building is to be erected is placed at $1,500,000, the interest thereon, at 4 per cent., is $60,000 per annum. If two years are consumed in construction of the new building, it will have cost in interest $120,000, to say nothing of the loss of rental on the old building. Moreover, if interest is charged on the cost of building from time to time as payments are made to the contractor in the course of its erection, this account is greatly increased. Presuming the cost of the building to be $1,000,000, and paid in, say, ten payments of $100,000 each, at intervals during the two years, this interest account would be made up somewhat in this way:

Interest, two years, on $1,500,000 at 4 per cent.	$120,000
Interest on installments of $1,000,000 at 4 per cent.	30,000
Total	$150,000

or 15 per cent. on the cost of the new building. I have used the 4 per cent. rate in this illustration because that is the common rate of interest on first-class mortgages, but I have known some important instances where the money was obtained at 3½ per cent., or even less. It is obvious, whatever the rate, that the new building should be constructed as rapidly as possible or as is consistent with good workmanship, to save as large a proportion of this interest as possible, and to make the enterprise begin to earn as soon as possible. For these reasons, then, and not for the purpose of merely making a record in rapid construction, such a building should, if practicable, be erected within a year. It is of comparatively small advantage to finish it within fourteen or sixteen months; for, assuming that rents are negotiated from May 1, the building must be completed before the first of next May, or carried over into the autumn. In order to accomplish such rapid construction drawings must be prepared considerably in advance, and the contracts should be let at least two months before the work is to be begun. This gives the contractor an opportunity to get the structural steel and other material under way in the shops, and have it ready when needed, and two months are the very least that should be allowed for this.

"Speaking of such enterprises from the financial aspect, it is a rule that holds almost invariably, that where the building costs less than the land, if properly managed, it is a success, and where it costs more than the land it is usually a failure. The land value is established by its location and desirability from a renter's standpoint; hence high rentals make high land values and conversely. * * * In my judgment, the best equation of building and land is that the building should represent about two-thirds of the land value under normal conditions."

Electric Train Lighting.

Electric lighting of railway trains has advantages so marked for this special purpose that, particularly in view of the strong tendency toward luxury in American travel, it is somewhat to be wondered at that its introduction has not been more general. Mr. George D. Shepardson, in the *Electrical World and Engineer*, summarizes these advantages as being "freedom from dripping and smell, smoke, and other products of combustion, open flame and danger from fire, and its uniformity, reliability, flexibility and general adaptability."

His paper, however, makes it plain that if the use has not become widely general, it has at least been highly perfected in special cases, the one he selects being on the Chicago, Burlington and Quincy road between Chicago and the twin cities, St. Paul and Minneapolis. The six roads joining these cities, while varying a good deal in mileage, have a uniform agreement as to minimum time and fare; the rivalry, therefore, centers largely in matters of equipment and comfort.

The C., B. & Q. was one of the first roads to experiment with electric lighting, but their efforts in 1886 were not satisfactory in the matter of cost, largely on account of the experimental state of the storage battery at that time. Eleven years later the work was revived with much better success. Mr. Shepardson expresses the belief that "with batteries charged at terminal stations under the best conditions, the total cost of lighting a train by electricity is less than by gas. It may possibly be reduced in the case of trains whose batteries are charged from dynamos driven from car axles, and probably yet more by making certain structural changes in the batteries.

"There are several systems of supplying current for railway trains, and each has its own field, being best suited for certain conditions. No one system is best for all. For solid through trains, such as those running between Chicago and Minneapolis, the ideal conditions prevail for the use of storage batteries. The night trains stand in the yards all day, and, while the car cleaners and inspectors are doing their work, the batteries can be charged without being removed from the cars, and without holding the cars from service a single moment. All handling of the cells, except as required for repairs or cleaning, is avoided, thereby removing one of the most prolific causes of deterioration found in some earlier attempts to use storage batteries for train lighting, as it was found that a single removal and replacement of the battery injured it more than a thousand miles of travel. In the case of the limited trains leaving in the evening and arriving in the morning, the battery is at its best; for when the train starts, the batteries have just received their charge, and the voltage is high, so that the lights are brightest when most needed."

The train taken by Mr. Shepardson as his example consists of five cars—a composite baggage and buffet, a standard sixteen-section sleeper, a compartment sleeper, a reclining-chair car, and a coach. The lighting is by both center and side fixtures. Pintsch lights are provided, but used only when the trains are in the terminal stations. The berth lamps are particularly convenient and useful, being of great comfort to those who wish to read, and under full control of the individual passenger.

"The total lighting of the train, exclusive of gas, is as follows:

	Lights.		Candle-power.
Buffet car	24	aggregating	368
Standard sleeper	74	"	824
Compartment sleeper	45	"	576
Dining car	49	"	640
Chair car	30	"	408
Coach	31	"	420
Transparency	12	"	120
Total for train	265	"	3356

"After a careful study of the conditions, the officials of the Burlington road decided that the system best adapted for their limited trains between Chicago and the Twin Cities was to use storage batteries charged at the ends of the line. Each car was therefore equipped with forty-eight cells of the Pullman and American type. The plates in the two kinds of battery look alike, the American being a pasted plate, while the Pullman is formed electro-chemically by the Planté process. The cells are rated at 160 amp.-hours, and each weighs about 56 lbs. Each cell contains four positive and five negative plates, each plate being 7 ins. high, 6 ins. wide and ½ (American) or ⅞ (Pullman) in. thick. The plates rest on treated wooden supports, clearing the bottom of the containing cells by about three-fourths of an inch. The hard rubber containing cells are 11 ins. high and 6½ ins. by 6¾ ins. wide, giving only one-quarter inch clearance between plates and cell. At first it was feared trouble might be caused by slopping of the acid when the train started or stopped suddenly, but by using deep cells extending about three inches above the tops of the elements, and by having little clear space on the sides, no trouble is experienced from that source. The 48 cells under each car are connected in series through rubber-covered flexible copper cables, and very little trouble is experienced from loose or broken joints. For convenience in handling, six cells are placed in a tray or crate with hardwood rollers and suitable handles. Four crates are placed in each of two boxes under the car floor, one box being on each side, to equalize space and weight. When the train is on the road the boxes are closed tightly by cover lids hinged at the bottom, but when the batteries are charging the covers are dropped to allow the gases to escape freely. Practically no trouble is caused either by fumes when charging or by entrance of dust when on the road.

"On some of the cars, ammeter jacks are placed near the battery boxes to facilitate measuring the charging current taken by each car. The battery terminals lead to one of the closets in the car, to a cabinet containing switches and fuse blocks for the two or more circuits of the car, and also two clips for voltmeter connection, to facilitate testing the condition of the batteries. Three cables, No. 00 B. & S. G., run the entire length of the train, being connected between cars by flexible couplings at the tops of the vestibules. All the battery circuits and lighting circuits are connected across two of the cables, thus equalizing the discharge of the batteries, however the loads in the individual cars may vary. When charging, the dynamo is connected between the two outside cables, so that each battery is charged at practically the same pressure.

"When the train arrives at the terminus, the electrician removes the cable couplings between the cars, so that each car may be lighted from its own battery. All the lights are then turned on and the voltage or the appearance of the lights is noted to see that the batteries are in good condition. The failure of any cell is thus readily detected and the cell replaced. The flexible couplings between the cars are then replaced and the charging current is turned on, the lamps, of course, being turned off while the batteries are charging.

"At Minneapolis, the charging begins with 85 amperes at 110 volts, increases to 100 amperes at 115 to 130 volts, and then drops off to 85 amperes at about 132 volts.

"Since the train lies in the Chicago yards two hours shorter time than at Minneapolis, the batteries are charged at a higher rate, beginning with 115 amperes at 115 volts and ending with 120 amperes at 136 volts. The charging stops about an hour before the train starts, allowing the temporary excess polarization to die away, so that the terminal voltage is about 98 when the lamps are first turned on. With all lamps lighted the voltage soon falls off to about 97, so that the lamps are not strained for any considerable length of time. Since the number of lamps in use drops off during the evening, and the rate of discharge diminishes accordingly, the voltage remains nearly constant all night, and no kind of regulation is required to maintain practically constant voltage on the lighting circuits.

"About once a month the cells are removed from the cars for thorough inspection and washing. At such times a deposit of mud from one-eighth to one-half inch deep is removed from the bottom of each jar. In setting up the cells, acid with specific gravity of 1.150 is used.

"The excessive weight of storage batteries has been urged as a serious objection to their use for lighting railway trains. As a matter of fact, with the heavy vestibuled trains now common, the weight of the battery averages less than 2 per cent. of that of the car it serves, so that this objection has little force.

"After an experience of three years with the batteries, the master mechanic, who has charge of these trains, is convinced that electricity is far superior to other methods for lighting trains, and that the battery system is more economical than the engine and dynamo."

THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.

Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.

California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer *s-m* Cleveland U. S. A.
Engineers' Gazette. *m* London.
Engineering. *w.* London
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* New York & London.
Engineering News *w.* New York
Engineering Record. *w.* New York
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age *w* New York.
Iron and Coal Trades Review *w.* London.
Iron & Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities *m.* Philadelphia, U. S. A.
Journal of Electricity *m.* San Francisco
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London
Journal of the Society of Arts. *w* London
Journal of U. S. Artillery *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago,
Journal of Worcester Poly. Inst.. Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w* Cleveland. U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter *w* Denver. U. S. A.
Mitt aus d Kgl. Tech. Versuchsanst Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature *w.* London.
Nature *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m* New York.
Oest. Monatsschr f d Oeft. Baudienst. *m.* Vienna.
Oest Zeitschr. f. Berg- & Hüttenwesen. *w* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York
Power *m.* New York.
Practical Engineer. *w* London.
Pro Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club, *m.* St. Louis, U. S. A
Progressive Age *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette *w.* New York.
Railway Age *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique *m.* Paris.
Revue Gen des Chemins de Fer. *m.* Paris.
Revue Technique *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American *w.* New York.
Scientific Am Supplement. *w.* New York.
Stahl und Eisen *s-m.* Düsseldorf.
Stevens Institute Indicator *qr.* Hoboken, U. S. A.
Stone. *m* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am Ins Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng New York.
Trans Am Soc of Civil Eng. *m.* New York.
Trans Am. Soc. of Heat & Ven. Eng. New York.
Trans Am. Soc. Mech. Engineers. New York.
Trans Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London
Western Electrician *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna
Yacht. *w* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr d. Ver Deutscher Ing *w.* Berlin
Zeitschrift für Elektrochemie. *w.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Baths.

See Plumbing and Gas Fitting, below.

Ceiling.

A Steel Vaulted Ceiling. Illustrated description of a Gothic church roof of steel beams with metal furring. 700 w. Eng Rec—July 14, 1900. No. 35251.

Chimneys.

Standard Specifications for Chimney Construction (Einheitliche Bestimmungen zur Berechnung der Standfestigkeit von Schornsteinen). Standard regulations for calculating the stability of chimneys and the allowable wind pressure, compiled by a committee of the Prussian Society of Steam Boiler Inspectors. 3000 w. Zeitschr d Ver Deutscher Ing—June 30, 1900. No. 35305 D.

Dome.

Construction of the Metallic Dome of the Schneider Pavilion at the Paris Exposition (Exposition de 1900. Pavillon de MM. Schneider & Cie. Construction de la Coupole Metallique). Ch. Dantin. A very well illustrated account of the construction of this building, in which movable staging and travelling cranes were used. 2 plates. 3500 w. Génie Civil—June 30, 1900. No. 35392 D.

Durability.

The Durability of Buildings and their Parts (Bestanddauer von Objecten und Objectstheilen). Prof. J. Röttinger. A long continued article on the age of buildings and the causes which affect their endurance. Partly theoretical, partly giving results of experience. Serial. 1st part. 1400 w. Wiener Bauindustrie Zeitung—June 28, 1900. No. 35369 D.

Fireproofing.

Second Church of Christ, Scientist, New York City. Illustrated description of a fireproof structure containing unusual features of arrangement and construction. 2500 w. Eng Rec—July 7, 1900. No. 35151.

Fireproofing Wood. Illustrated description of the latest method, invented by Joseph L. Ferrell. 2500 w. Sci Am—July 28, 1900. No. 35529.

Tests of Fire Retardent Materials. Charles L. Norton. Describes experiments and tests carried out with a view to determining the efficiency of several means of protecting wooden surfaces from fire. 4000 w. Tech Quar—June, 1900. No. 35209 E.

Horticultural Palace.

The Palaces of Horticulture at the Paris Exposition (Exposition de 1900. Les Palais de l'Horticulture). M. Adémar. A well illustrated description of the Horticultural buildings at the Exposition. 1 plate. 1500 w. Génie Civil—June 23, 1900. No. 35389 D.

Labourers' Dwellings.

The Internal Arrangement of Labourers' Dwellings, particularly of the Kitchen and Heating Apparatus (Die Innere Einrichtung von Arbeiterwohnungen, insbesondere die Gestaltung der Küche und das Zweckmässige Anbringen der Heizanlagen). Prof. H. C. Nussbaum. Abstract of a paper before the Rheinische Verein zur Förderung des Arbeiter-Wohnungswesens, discussing ventilating, heating and kitchen questions. 1200 w. Gesundheits Ing—May 31, 1900. No. 35372 B.

Principles.

Principles of Construction for Architectural Students. E. Wyndham Tarn. Part first discusses foundations, concrete, and piling. 1000 w. Archt, Lond—July 6, 1900. Serial. 1st part. No. 35295 A.

Public Buildings.

The Collaboration of the Architect, the Painter, and the Sculptor. The subject from the view of an architect was discussed by E. W. Mountford; the view of the painter, by W. B. Richmond; and the view of the sculptor, by E. Roscoe Mullins. Three papers and discussions before the Roy. Inst. of Brit. Archts. 9000 w. Builder—June 23, 1900. No. 35095 A.

The Necessity for Official Control over Architecture in Our Towns and Cities. William Emerson. Read before the Roy. Inst. of Brit. Archts. Considers points for and against such control. Also discussion. 8000 w. Builder—June 23, 1900. No. 35094 A.

Rapid Building.

The Financial Importance of Rapid Building. Describes the erection of an 18-story office building in less than fourteen months, and gives reasons for the importance of such rapid construction. 1800 w. Eng Rec—June 30, 1900. No. 35107.

Specifications.

See same title under Mining and Metallurgy, Iron and Steel.

Supporting Power.

The Supporting Power of Rocks and Soils. Hugh Leonard. An account of experiments made at Calcutta, with tabulated results. 700 w. Jour Roy Inst of Brit Archts—June 16, 1900. No. 35196 B.

HEATING AND VENTILATION.

Blower System.

Ventilation and Heating. W. B. Snow. Read before the Applied Science Soc. of McGill Univ. Illustrates and describes the hot-blast apparatus for combined heating and ventilating, and discusses other systems. 2200 w. Can Engr—July, 1900. Serial. 1st part. No. 35165.

Church.

Ventilation and Heating of a Montclair, N. J., Church. Illustrated description of the arrangement of a church with unusually complete appointments, using both direct and indirect systems of steam heating. The method followed in computing the heating apparatus is explained in some detail. 1500 w. Eng Rec—July 14, 1900. No. 35252.

Gas Heating.

Faulty Gas Stoves and Bath Heaters. A. Gartner. From the *Journal für Gasbeleuchtung.* Summary. Explains the difference between heating and lighting burners, discusses the dangers, and danger indicators. 2400 w. Gas Wld—July 21, 1900. No. 35590 A.

The Efficiency of Gas Heating (Der Nutzeffect der Gasheizung). Erwin Nicolaus. Discussion of the theory, practical results with a variety of gas stoves, and costs; with tables. 3500 w. Gesundheits Ing—June 30, 1900. No. 35373 B.

Gas Heating (Ueber Gasheizung). Erwin Nicolaus. A general discussion of the subject, with table showing amount of products of combustion under various circumstances. Serial. 2 parts. 3200 w. Gesundheits Ing—May 31, June 15, 1900. No. 35370 each B.

Library.

The Providence Public Library. Illustrated description of the general design of a building for 225,000 volumes, with numerous rooms for educational and other purposes; the heating arrangements are explained in detail. 3300 w. Eng Rec—July 21, 1900. No. 35459.

Public Buildings.

Ventilation and Heating of Public Buildings. P. H. Bryce. Read before the Engng. Soc. of the Sch. of Prac. Science, Toronto. Discusses the house air, and means whereby it may serve the requirements of health. 5400 w. Can Archt—July, 1900. No. 35466 C.

PLUMBING AND GAS FITTING.

City Residence.

Plumbing in a Large City House. Illustrated description of unusually elaborate work in a New York residence. 1000 w. Eng Rec—July 28, 1900. No. 35614.

Hospital.

Plumbing in the Manhattan State Hospital. Illustrates and describes the special plumbing features of a large asylum for the insane. 1400 w. Eng Rec—July 7, 1900. No. 35150.

Model Plumbers.

The Model Plumber, from an Architect's Standpoint. O. J. Pierce. Considers the work of the contracting plumber. 3400 w. Dom Engng—July 15, 1900. No. 35465 C.

Public Baths.

Prize Plans for Public Baths (Preisentwürfe für Volksbäder). Franz Loewenstein. An illustrated account of the plans which received prizes at a recent competition instituted by the Deutsche Gesellschaft für Volksbäder, in Berlin. Serial. 2 parts. 1 plate. 3400 w. Gesundheits Ing—May 31, June 15, 1900. No. 35371 each B.

Rain-Baths.

A Plea for Rain-Baths in the Public Schools. Advocates the introduction of rain-baths in the tenement districts, showing why this form is the best. 4500 w. Am Archt—July 14, 1900. Serial. 1st part. No. 35262.

MISCELLANY.

Chimneys.

The Highest Chimney in the World. Louis Fort. Illustrates and describes a chimney in Germany which has a height of 459 feet above the surrounding plane. It is erected on a hill which gives it height equivalent to 656 feet. 900 w. Power—Aug., 1900. No. 35646.

Education.

Architectural Education in the United States of America. Arthur Cates. Reviews various courses available to students. 3400 w. Jour Roy Inst of Brit Archts—June 16, 1900. No. 35197 B.

Engineering Building.

The New Engineering Building of the University of Wisconsin. J. B. Johnson. Description with illustration and plans. 6000 w. Jour W Soc of Engs—June, 1900. No. 35140 D.

Illumination.

Prismatic Lighting for the Illumination of Dark Interiors. Wm. H. Greene. A brief review of the art of prismatic lighting. Ill. 2500 w. Jour Fr Inst—Aug., 1900. No. 35593 D.

Library.

The Stickler Memorial Library, Orange, N. J. Illustrated description of building for 45,000 volumes. 600 w. Eng Rec—June 30, 1900. No. 35105.

The Congressional Library. An abbreviated description and illustrations of this fine library in Washington, D. C. 1000 w. Archts & Builds' Mag—July, 1900. No. 35120.

See also same title under Heating and Ventilation, above.

Paris Exposition.

A Trip About Paris and the Exposition (Ein Rundgang durch Paris und die Weltausstellung). H. Koestler and P. Kortz. From an address before the Oest. Ing. und Arch. Verein by H. Koestler, giving a general description of the Exposition, with illustrations. 3500 w. Zeitschr d Oest Ing u Arch Ver—July 6, 1900. No. 35346 B.

The Paris Exposition (Die Weltausstellung in Paris). An illustrated general description of the Exposition grounds and buildings. Serial. 1st part. 3500 w. 1 plate. Oest Monatschrift f d Oeff Baudienst—June, 1900. No. 35338 G.

CIVIL ENGINEERING

BRIDGES.

Aqueduct.

The Briare Canal Bridge. Illustrated description of an aqueduct bridge in France, noteworthy for the details of the large metal trough. 900 w. Eng Rec—July 7, 1900. No. 35147.

Bascule.

The Chicago Type of Bascule Bridge. Illustrated description of the general design and special details of a trunnion-type bascule with special brakes, buffers, locking gear and piers. 2300 w. Eng Rec—July 21, 1900. No. 35455.

Cantilever.

A Cantilever-Arch Bridge at the Paris Exposition. Illustrated description of a foot-bridge over the Seine, erected as a cantilever, but acting as an arch when completed, with the roadway as a horizontal tie between the ends. 1200 w. Eng Rec—July 14, 1900. No. 35248.

Drawbridge.

The Passaic River Drawbridge. Illustrated description of the reconstruction and enlargement of the turntable of a plate-girder swing span. 700 w. Eng Rec—June 30, 1900. No. 35102.

Foot-Bridges.

Foot-Bridges which Connect Different Parts of the Exposition at Paris (Exposition de 1900. Passerelles Réunissant entre elles les Différentes Partie de l'Exposition). An illustrated general description of iron and wooden bridges across the Seine and roadways. 1400 w. Génie Civil—July 7, 1900. No. 35395 D.

Lift Bridges.

The Lift or Bascule Type of Movable Bridges. A statement of the relative merits of swing and lift bridges. 1000 w. Eng Rec—July 28, 1900. No. 35607.

Military Bridge.

Military Bridge Over the Oder River (Kriegsbrückenschlag über die Oder). A short, well illustrated description of a trestle-work wooden bridge, 632 meters long, built in 20 days by 50 officers and 1,500 men. 1 plate. 200 w. Wiener Bauindustrie Zeitung—May 24, 1900. No. 35366 D.

Old Rails.

Use of Old Rails in Overhead Bridges, N. S. W. Govt. Rys. Detailed drawings and description of these bridges, showing the practicability of utilizing old rails for this purpose. 1000 w. Ry & Engng Rev—July 7, 1900. No. 35166.

Paris Exhibition.

The Exhibit of Typical American Bridges at the Paris Exposition. George L. Fowler. Engravings of ten drawings illustrating typical designs of some of the notable railway bridges, with descriptions. 4000 w. Eng News—July 5, 1900. No. 35186.

Siberian Railway.

Building the Bridge Across the Yenisei. Illustrates and describes the method of using the local wood for the caissons of the bridge pillars. 1200 w. Engr, Lond—July 6, 1900. No. 35413 A.

Thomas Steel.

The Steel Question in Austria (Die Flusseisenfrage in Oesterreich). Prof. Mehrtens. A review of the production of Bessemer. Thomas and Martin steel in Austria, and a discussion of the report of the bridge-material committee of the *Oesterr. Ingenieur und Architekten Verein* on the admissibility of Thomas steel in bridge construction. 2500 w. Zeitschr d Ver Deutscher Ing—July 7, 1900. No. 35308 D.

Viaduct.

Riverside Drive Viaduct, New York. Illustrations and brief description of the interesting features of a viaduct being constructed to connect Riverside Drive with the driveways further north. 1200 w. Sci Am—July 21, 1900. No. 35423.

The Design and Cost of Viaducts

(Ueber Anlage und Kosten der Bahnviadukte). Rob. Moser. A comparison of the cost of stone and iron viaducts, to the advantage of the former; with curves and tables. 1800 w. Schweiz Bauzeitung —June 30, 1900. No. 35364 B.

The Gokteik Gorge Viaduct. Illustrations and brief description of the bridge works on the Mandalay Ry., India. 900 w. Ind & East Engr—June, 1900. No. 35496 B.

CONSTRUCTION.

Concrete.

Concrete Masonry Construction at Low Temperatures. A statement of the conditions which must be filled to ensure good work during freezing weather. 900 w. Eng Rec—July 21, 1900. No. 35453.

Macadam.

The Thickness of Macadam Material. Illustrates the difference between old and modern roads, and discusses the thickness required to resist the pressure from traffic. 800 w. Sci Am Sup—July 21, 1900. No. 35425.

Monier Constructions.

Monier Constructions. E. Lee Heidenreich. Explains the general construction, its principal qualities, and illustrates where it has been successfully applied. Also discussion. 10000 w. Jour W Soc of Engs—June, 1900. No. 35142 D.

Piers.

The Failure and Repair of the Piers of the Aqueduct Bridge, Washington, D. C. L. R. Grabill. Illustrated description of the damage and methods adopted in making repairs. 3800 w. Eng News—July 26, 1900. No. 35533.

Roads.

Road Making and Road Metal. Considers the methods of Telford and MacAdam, and the materials used. 1900 w. Auto Jour—July, 1900. No. 35494 A.

Road Drainage. Arthur Newhall Johnson. Extract from an article in the report of the Maryland Geol. Survey for 1899. Illustrated description of methods. 2200 w. Brick—Aug. 1, 1900. No. 35701.

Roads for Mining Purposes. C. C. Longridge. Discusses the principles and problems of construction of mining roads, routes, gradients, drainage, etc. 3500 w. Engng—July 13, 1900. No. 35500 A.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplon Tunnels). C. J. Wagner. A full report of the progress made on this great undertaking to the end of 1899, with maps. 6500 w. Zeitschr d Oest Ing u Arch Ver—May 25, 1900. No. 35341 B.

The Simplon Tunnel. Illustrated description of the methods adopted at each end of this tunnel, and a statement of work accomplished up to 1900. 3000 w. Eng Rec—July 7, 1900. No. 35146.

Stresses.

The Bending Stresses on Flat Rectangular Concrete Floors. Frank Cows. A criticism of paper by W. Dunn. 1800 w. Jour Roy Inst of Brit Archts—June 30, 1900. No. 35525 B.

Superstructure.

Concrete Pier Superstructure for the New Ship Canal Entrance to Duluth Harbor, Minn. Illustrates the revised designs and describes the general construction. 3500 w. Eng News—July 26, 1900. No. 35534.

Tunnel.

Argo or Newhouse Tunnel. Arthur Lakes. The purpose for which it is being driven and the method of driving. Ill. 3800 w. Mines & Min—Aug., 1900. No. 35686 C.

Tunneling.

Tunneling with Shields. Illustrated extracts from paper of H. H. Dalrymple-Hay, before Inst. of C. E., describing the different methods of shield tunneling on the Waterloo and City Railway, particular attention being given to methods of timbering in advance of the shield in water-bearing strata. 5500 w. Eng Rec —July 14, 1900. No. 35250.

The Great Alpine Tunnels. Francis Fox. A discourse delivered at the Royal Inst. Considers tunneling and the remarkable instances of the past, discussing in detail the Mont Cenis, St. Gothard and Simplon tunnels. Ill. 4000 w. Nature—July 19, 1900. No. 35606 A.

Wharf.

A Large Steel Pier Shed. Illustrates and describes the design and methods of construction of the 736 x 120-ft. pier-shed of the White Star Line in New York, one of the last to be built prior to the fire on the piers of the North German Lloyd line in Hoboken. 2500 w. Eng Rec—July 28, 1900. No. 35613.

Iron-Ore Loading Docks. Waldon Fawcett. An illustrated account of construction under way which will make a holding capacity of 800,000 tons at the Great Lakes. 2000 w. Am Mfr & Ir Wld —July 19, 1900. No. 35472.

Fires on Freight Piers. Editorial discussion of the construction of freight piers to diminish fire hazards. 1000 w. Eng Rec—July 14, 1900. No. 35244.

HYDRAULIC AND WATER SUPPLY.

Austin Dam.

Concerning the Austin Dam. R. D. Parker. Illustrated reports from various sources on the results of soundings at low water to determine the manner of failure of a 67-ft. masonry dam; these point to undermining as the cause. 1700 w. Eng Rec—June 30, 1900. No. 35101.

The Austin Dam. Report by H. B. Patterson, in charge of this 60-ft. masonry dam, describing the reason for its recent failure. 900 w. Eng Rec—July 28, 1900. No. 35610.

Breakwater.

The Reaction Breakwater as Proposed for the Opening of the South-West Pass of the Mississippi River. Lewis M. Haupt. An explanation of the problem to be solved and the plans proposed. Ill. 5000 w. Jour Fr Inst—July, 1900. No. 35159 D.

Canal Haulage.

See Electrical Engineering, Power Applications.

Canalization.

The Work of the Commission for Canalizing the Moldau and Elbe Rivers in Bohemia in 1899 (Die Thätigkeit der Commission für die Canalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1899). An illustrated account of the improvements in progress on these rivers. 1800 w. Oest Monatschrift f d Oeff Baudienst—June, 1900. No. 35339 G.

Canals.

The Elbe-Trave Canal (Der Elbe-Trave Kanal). A full and very well illustrated account of this 42-mile canal between Lübeck and Lauenburg on the Elbe, with its locks and the bridges crossing it. Compiled from official sources. 12000 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 16, 1900. No. 35300 D.

The Rhine-Elbe Canal Project. Information concerning a great project for increasing the traffic facilities in Germany. 4400 w. Engng—June 22, 1900. No. 35112 A.

Docks.

Naval Docks of the United States. Illustrated detailed description of the machine being built for the government at Baltimore. It is large enough and strong enough to lift the Oceanic. 2000 w. Am Mfr & Ir Wld—June 28, 1900. No. 35098.

The Dockization of the Avon. Review of the report to the Dockization Committee of the City of Bristol, Eng., in reference to a gigantic scheme to provide necessary accommodation for modern vessels. 2200 w. Transport—June 22, 1900. No. 35093 A.

See also Wharf, under Civil Engineering Construction.

Dredges.

See Marine and Naval Engineering.

Hydrology.

The Kimberly & Clark Paper Mill at Quinnesec Falls. Illustrated description of the hydrology of a river-shed utilized by a large paper-mill in Wisconsin. 2800 w. Eng Rec—June 30, 1900. Serial. 1st part. No. 35106.

Irrigation.

Irrigation Works in the Jeypore State, Rajputana, India. Charles Egremont Stotherd. A short description of some of the works, showing the different methods adopted, and the results attained. Ill. 4400 w. Ind & East Engr—June, 1900. No. 35497 B.

Isthmian Canal.

The Topography of the Nicaragua Canal Route, and the Plans and Estimated Cost of Constructing the Canal. E. S. Wheeler. Presents the principal results of the Nicaragua Canal Commission's report, without data or discussion, giving a map showing the topography of the region. 7200 w. Eng News—July 12, 1900. No. 35254.

Kutter Formula.

Hydraulic Diagrams. Letter from T. Horton and editorial reply on the best methods of plotting the Kutter formula. 2000 w. Eng Rec—July 28, 1900. No. 35615.

Meters.

Practical Experience with Water Meters at Lexington, Ky. S. A. Charles. Read before the Am. Water Works Assn. Considers difficulties real and imaginary in the use of meters. 2000 w. Fire & Water—July 7, 1900. No. 35157.

Nicaragua.

See Isthmian Canal.

Pipes.

Wooden Water-Supply Piping. Illustrated description of pipe constructed on an estate in North Wales, for bringing water to a farm for driving a mill and for pumping a supply for nine different farms. 1300 w. Engng—July 20, 1900. No. 35571 A.

Rating.

The Rating of Water Undertakings. F. J. Bancroft. Read before the British Assn. of Water-Works Engs. An explanation and discussion of British practice. 11000 w. Jour Gas Lgt—July 3, 1900. No. 35274 A.

Reservoirs.

The Staines Reservoirs Scheme. On the progress of the work of building storage reservoirs in the valley of the Thames to furnish London with additional supply of water. 1600 w. Jour Gas Lgt—July 3, 1900. No. 35273 A.

The Grand Rapids Reservoir Accident. Lewis D. Cutcheon. Illustrated description of the washout of the earth bank of a 6,000,000 gallon reservoir, due to lack of overflow provision. 1200 w. Eng Rec—July 14, 1900. No. 35246.

The Failure of the Distributing Reservoir of the Water-Works of Grand Rapids, Mich. An illustrated account of the accident, believed to be due to overfilling the reservoir. 1200 w. Eng News—July 12, 1900. No. 35255.

Siphons.

Siphons. Thomas McKeown. Notes on the history of siphons, and their use in water supplies and sewage transfer. Discussion. 2200 w. Jour Assn of Engng Socs—June, 1900. No. 35400 C.

Water Pipes.

20-inch Steel Pipe Substituted for 30-in. Cast-Iron Pipe at a Railway Crossing in Boston. H. F. Winslow. Illustrates and describes a change made necessary by a new railway connection which must pass under the street. 350 w. Eng News—July 26, 1900. No. 35532.

Water Power.

See Mechanical Engineering, Hydraulics.

Water Supply.

Impure and Unwholesome Water and Its Experimental Improvement. Floyd Davis. Discusses the improvement due to the education of the common people and their better understanding of the danger, calling attention to some organisms that are proof of unwholesomeness. 1800 w. Munic Engng—Aug., 1900. No. 35655 C.

New Jersey Forests and Their Relation to Water Supply. C. C. Vermeule. Read before the Am. Forestry Assn. Claims that run-off is not affected as to total quantity to any appreciable degree by forests, but depends on temperature and rainfall. Also editorial giving formula based on the conditions observed in many catchment areas. 4000 w. Eng Rec—July 7, 1900. No. 35149.

Notes on the Geology of the Sites of the Proposed Dams in the Valleys of the Housatonic and Ten-Mile Rivers. W. O. Crosby. Describes the geology of a region investigated in view of securing water for the supply of Greater New York. 3000 w. Tech Quar—June, 1900. No. 35208 E.

Outline of the Geology of Long Island in its Relation to the Public Water Supplies. W. O. Crosby. Sketch of that part of Long Island that has a bearing on the supply for Greater New York. 7500 w. Tech Quar—June, 1900. No. 35207 E.

The New York Water Supply. A statement of the imminent danger of a water famine in five years in New York, and recommendations of J. R. Freeman for obtaining new supplies. 1600 w. Eng Rec—June 30, 1900. No. 35100.

Water Supply in Various Cities. Interesting tables compiled from information concerning the water supply in cities of America, England and Australia for the year 1898. 600 w. Engr, Lond—June 22, 1900. No. 35111 A.

Water Tower.

The City Water Works in the Favoriten District of Vienna (Das Städtische Wasserwerk in Favoriten). A well illustrated description of a highly ornamental water tower and pumping station. 2 plates. 800 w. Wiener Bauindustrie Zeitung—June 21, 1900. No. 35367 D.

New Water Tower at Murphysboro, Ill. Illustrated detailed description of an elevated tank with spherical bottom, encased in wood and provided with horizontal stiffening girders. 1300 w. Eng Rec—July 7, 1900. No. 35148.

Water Waste.

The Relationship between Cost of Water Wasted and Cost of Detection and Prevention of Waste. A. J. Jenkins. Abstract of paper read before the British Assn. of Water-Works Engs., discussing this subject. Also general discussion. 5000 w. Jour Gas Lgt—July 10, 1900. No. 35484 A.

Waterways.

Two Hundred Million. Considers the final report of the deep waterways commission, dealing with routes for a ship canal within United States territory from the Great Lakes to the Atlantic. 2000 w. Marine Rev—July 12, 1900. No. 35236.

Water Works.

Construction of the Binghamton Suction Well. Illustrated description of a pump well 33½ ft. in diameter and 24 ft. deep, which was sunk by means of a pneumatic caisson. 600 w. Eng Rec—July 28, 1900. No. 35612.

The Jersey City Water-Works. Illustrated description of the 50,000,000-gal. gravity works now under construction, which include a masonry dam over 100 ft. high, an aqueduct of riveted steel pipe and masonry and a long tunnel. 4000 w. Eng Rec—July 21, 1900. No. 35458.

MATERIALS.

Cement.

Conditions in Portland Cement Kilns. Edward Duryea. Illustrates and describes the form of rotary kiln recently used by the writer and a statement of its advantages. 1200 w. Eng News—Aug. 2, 1900. No. 35693.

Model Specifications and Tests for Cement. A copy of the specifications for the city of Pittsburg for the construction of bridges, streets and sidewalks. 2700 w. Munic Engng—July, 1900. No. 35134 C.

Portland Cement. Concerning cement manufacture, the materials and treatment and system of testing. 4300 w. Builder—July 14, 1900. No. 35495 A.

The First Manufacturers of Portland Cement by the Direct Rotary Kiln Process. E. Duryee. An account of work at Rondout, N. Y., and at Montezuma, N. Y. 700 w. Eng News—July 26, 1900. No. 35536.

The Development and Future Prospects of Portland Cement Manufacture in America. Considers the recent and rapid growth of this industry in the United States, to what it is due, and the probability of its enduring. 3500 w. Eng News —July 26, 1900. No. 35535.

The Virginia Portland Cement Company's Works. Watson Vredenburgh, Jr. Illustrated description of a plant at Craigsville, W. Va., in which both shafting and electricity are employed to transmit power. The course of the materials from the quarries to the bags and barrels ready for shipment is followed in detail. 2700 w. Eng Rec—July 28, 1900. No. 35609.

Concrete.

Economical Concrete Mixing. A. McLean Parker. Illustrated description of plant for mixing concrete in a very confined situation. 600 w. Eng Rec—June 30, 1900. No. 35103.

Roads.

Qualities of Good Road-Metals. Harry Fielding Reid. From the Maryland Geological Survey. On the methods of selecting and testing road material. 2800 w. Stone—July, 1900. No. 35450 C.

Specifications.

See same title under Mining and Metallurgy, Iron and Steel.

Timber.

Preservation of Timber. Written and oral discussion of Mr. Chanute's paper on this subject. 5000 w. Jour W Soc of Engs—June, 1900. No. 35141 D.

MEASUREMENT.

Levelling Rod.

A Compensated Rod for Precise Levelling (Ueber eine Kompensationslatte beim Präcisions-nivellement). Dr. J. Hilfiker. An illustrated description of a wood, brass and iron levelling rod, compensated for temperature changes. Serial. 2 parts. 3000 w. Schweiz Bauzeitung—June 16, 23, 1900. No. 35362 each B.

Surveying.

A Beam Compass for Plotting Surveys. C. Gregorie. Describes an instrument with which measurements of one link and less can be accurately plotted on plans of two chain and 1-2500 ordnance scale. 900 w. Col Guard—July 6, 1900. No. 35-286 A.

Tape Tension.

A Surveying Tape Tension Equalizer (Der Messband-Spanner. Ein Markscheiderisches Hilfsinstrumentchen). M. Przyborski. An illustrated description of a spring hook for holding the end of a surveying tape so as to stretch it equally whenever in use. 400 w. Oest Zeitschr f Berg u Hüttenwesen—June 16, 1900. No. 35356 B.

MUNICIPAL.

Beautiful Cities.

I. The Ideal City. Halsey Recardo. II. Streets and Bridges. Considered in Connection with Our Unideal City. W. D. Caröe. III. The Sculptor's Point of View. T. Stirling Lee. Papers and discussion before the Royal Inst. of Brit. Archts. 12000 w. Builder—June 23, 1900. No. 35096 A.

Fire Alarm.

See Electrical Engineering, Communication.

Garbage.

See Refuse, below.

Macadam Pavement.

See Civil Engineering, Construction.

Parks.

Parks and Boulevards. A. C. Schrader. Suggestions for their construction and maintenance. General discussion. 12400 w. Jour W Soc of Engs—June, 1900. No. 35139 D.

Pavements.

Pavements in Switzerland. Report of experiments made in Basle with wood pavements, including American pitch pine. 700 w. U. S. Cons Repts, No. 772 —July 5, 1900. No. 35138 D.

Public Buildings.

See Architecture and Building.

Rapid Transit.

See Street and Electric Tramways.

Refuse.

Garbage Reduction at Columbus, O. Describes the manner of collecting, and treatment at the reduction works. 2200 w. Eng News—July 19, 1900. No. 35440.

Review of Different Methods of Treating Refuse (Considérations sur les Divers Modes de Traitement des Ordures Ménagères). Ach. Livache. A general discussion of the various economical methods of garbage disposal, with many references to American and British practice. 7000 w. Bull de la Soc d'Encour—May 31, 1900. No. 35565 G.

Roads.

See Civil Engineering, Construction.

Sanitation.

Some Phases of Public Sanitation. E. C. Gardner. Calls attention to practices in cities and towns that cause illness and discomfort. 5000 w. Am Archt—July 28, 1900. No. 35580.

Sewage.

The Bacterial Treatment of Sewage in England. William Easby, Jr. Considers the operation of the bacterial systems and the results obtained by them. Illustrations and discussion. 12800 w. Pro Engs' Club of Phila—July, 1900. No. 35275 D.

Sewers.

Sewer Maintenance. W. C. Parmley. Discusses what is an adequate and efficient system of sewerage, and its maintenance, after being put in operation. 5500 w. Jour Assn of Engng Socs—June, 1900. No. 35403 C.

MISCELLANY.

Address.

Presidential Address, American Society of Civil Engineers. John Findley Wallace. London address on the status of the engineering profession. 3200 w. Eng Rec—July 14, 1900. No. 35249.

China.

See Railways Affairs, New Projects.

Contractor's Rights.

The Rochester Conduit Litigation. A review of a suit lasting eight years, just settled by the U. S. Supreme Court in a decision refusing to consider a surety on a bid, or the bidder, bound by the terms of a tender when the bidder's representative announces as soon as his bid has been read and before that of another bidder has been opened, that certain figures in his tender were errors. 2800 w. Eng Rec—July 28, 1900. No. 35608.

Cycleway.

A California Cycleway. Charles Frederick Holder. Illustrates and describes an interesting construction between Pasadena and Los Angeles, for bicycles and motorcycles. 1500 w. Sci Am—July 14, 1900. No. 35239.

Education.

Doctors of Engineering. A statement of the new Prussian regulations authorizing technical schools to grant a doctor's degree in engineering equivalent to one in philosophy. 800 w. Eng Rec—July 14, 1900. No. 35245.

Industrial Education in America. Report of a committee of the Soc. for the Promotion of Engng. Ed., read at N. Y. meeting. 7500 w. Eng News—July 12, 1900. No. 35257.

Labor.

Trusts and Their Relation to the Engineer. Charles H. Wright. Discusses the effect of the trusts on labor, the meaning of the term, the advantages, etc. 3800 w. Jour Assn of Engng Socs—June, 1900. No. 35401 C.

Porto Rico.

The Material Deveyopment of the Island of Porto Rico. Albert W. Buel. Suggestion of immediate needs—chiefly good roads—and warning against undue expectations until education and emulation have wakened the people to a higher plane of living, with its larger demands. Finely illustrated. 3600 w. The Engineering Magazine—Aug., 1900. No. 35634 B.

Societies.

The Largest Engineering Society. Describes the organization and work of the Society of German Engineers, which had 13,928 members at the close of 1899. 1100 w. Eng Rec—July 21, 1900. No. 35454.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Practical Transmitter Using the Sine Wave for Cable Telegraphy; and Measurements with Alternating Currents upon an Atlantic Cable. Albert C. Crehore and George O. Squier. Full paper. Describes a method of utilizing the sine wave for cable signaling, and a practical cable transmitter employing these principles. Ill. 8000 w. Trans Am Inst of Elec Engs—May, 1900. No. 35231 D.

The Projected Cable Line to the Philippines. Chandler Hale. Discusses the feasibility of a trans-Pacific cable owned by the government, and the Alaskan route as compared with the southern route from San Francisco to Manila. 2700 w. N Am Rev—July, 1900. No. 35156 D.

Duplex.

Duplex and Diplex Transmission by Means of Electric Waves (Transmissions Duplex et Diplex par Ondes Electriques). Albert Turpain. A short account of a system using both continuous currents and electric waves. 500 w. Comptes Rendus—May 14, 1900. No. 35398 D.

Fire Alarm.

What Are the Requirements of a Fire Alarm System in Medium-Size and Large Cities (Welche Anforderungen sind an eine Feuermelde-Einrichtung in Mittleren und Grösseren Städten zu Stellen)? C. v. Moltke. A paper read before the Verband Deutscher Elektrotechniker containing a general discussion of the subject. 1100 w. Elektrotech Zeitschr—June 21, 1900. No. 35312 B.

Graphophone.

The Graphophone Grand. Report of committee of the Franklin Inst. on the invention of Thos. H. Macdonald, and embracing a general history of sound-recording and reproducing devices, with a supplement by Philip Mauro. Ill. 6900 w. Jour Fr Inst—July, 1900. No. 35160 D.

Harmonic Telegraph.

The Mercadier Harmonic Telegraph System (Télégraphe Harmonique de M. Mercadier). A. Fleury. An illustrated description of the system, which is based on the harmonic vibration of tuning forks, with an account of a telephonic relay. 2200 w. Electrician—June 9, 1900. No. 35557 B.

Multiplex.

The Mercadier Multiplex Telegraph System (Télégraphie Multiple Réversible ou Multiplex Système E. Mercadier). G. Briand. An illustrated description of a system which works by the inductive action of undulatory currents. 1400 w. Génie Civil—June 16, 1900. No. 35388 D.

Space Telegraphy.

Arrangement Intended to Prevent the Interception of Despatches in Wireless Telegraphy. D. Tommasi. An illustrated description of the arrangement. 800 w. Elec Rev, Lond—July 13, 1900. No. 35476 A.

Syntony in Wireless Telegraphy (Sur la Syntonie dans la Télégraphie sans Fil). A. Blondel. A description of a system of selective signalling by means of a telephone and resonating circuits. 700 w. Comptes Rendus—May 21, 1900. No. 35550 D.

Wireless Telegraphy Experiments with a Free Balloon (Experiences de Télégraphie sans Fil en Ballon Libre). J. Vallot, J. and L. Lecarme. The receiver was on the balloon and signals were received at a height of 800 meters and at a distance from the transmitter of 6 kilometers. 500 w. Comptes Rendus—May 14, 1900. No. 35399 D.

The Maximum Sensitiveness of Coherers in Practical Use in Wireless Telegraphy (Sur la Sensibilité Maxima des Cohéreurs Employés Pratiquement dans la Télégraphie sans Fils). A. Blondel and G. Dobkévitch. A short account of a method of controlling the sensitiveness of a coherer by altering the pressure on the filings by increasing their amount. 600 w. Comptes Rendus—April 23, 1900. No. 35397 D.

Telegrams.

Six Penny Telegrams—Why They Do Not Pay. J. Henniker Heaton. Discusses the British telegraph service. 4200 w. Nineteenth Cent—July, 1900. No. 35449 D.

Telegraphone.

The Paulsen Telegraphone (Le Télégraphone de M. Paulsen). M. Aliamet. An illustrated description of this apparatus, in which a magnetic record is made on a steel wire or tape. 1000 w. Electrician—June 2, 1900. No. 35554 B.

The Telegraphone (Das Telegraphon). Dr. Thomae. A short illustrated description of the Paulsen magneto-telephonograph, in which an electromagnet, in circuit with a microphone, makes a magnetic record on a steel wire or tape. 1200 w. Zeitschr d Ver Deutscher Ing—June 30, 1900. No. 35304 D.

Telephone.

The Railway and the Telephone. Henry W. Pope. Read before the Ry. Telegraph Supts.' Assn., at Detroit, Mich. The possibilities of the telephone, and its adaptability to railroad service. 3500 w. St. Louis Ry Club—July 13, 1900. No. 35452.

The Use of the Telephone in the Working of Railway Traffic. Thomas Ireland. Prepared for the International Ry. Cong. Discusses its usefulness and limits, and considers it an important auxiliary. 2000 w. Transport—July 13, 1900. No. 35481 A.

Burgunder Telephone System (Transmetteurs et Recépteurs Telephoniques Système Burgunder). L. Montillot. An illustrated description of transmitter and receiver and other details of the system. 1000 w. Electricien—June 23, 1900. No. 35500 B.

A Curious Telephone Experiment (Une Curieuse Expérience Téléphonique). Em. Pièrard. An illustrated description of experiments in which sounds were produced by currents due to the volta contact effect of metals. 1400 w. Electricien—May 19, 1900. No. 35551 B.

Ducousso Telephone Transmitters and Receivers (Transmetteurs et Recepteurs Téléphoniques Système Ducousso). L. Montillot. An illustrated description of the system. The transmitters are granular carbon microphones; the receiver magnet is circular. 800 w. Electricien—June 2, 1900. No. 35555 B.

DISTRIBUTION.

Alternator.

A String Alternator. K. Honda and S. Shimizu. Describes a modified form of Pupin's interrupter, used as an alternator. 600 w. Am Jour of Sci—July, 1900. No. 35136 D.

Arc Lamps.

Arc Lamp Distribution. Alton D. Adams. A discussion of the systems of arc lamp operation. 2500 w. Elec Rev, N. Y.—July 25, 1900. No. 35542.

Boosters.

Direct Current-Boosters. Claude W. Hill. Illustrates and describes a track feeder booster with its motor. 700 w. Elec Rev, Lond—July 6, 1900. No. 35293 A.

Converting-Machinery.

On Converting-Machinery for Tramway Sub-Stations. A. C. Eborall. Discusses some fundamental considerations relating to rotary converters and motor-generators for use in sub-stations. Considers that in the majority of cases motor-generator equipments will give the best results in actual working. 2000 w. Tram & Ry Wld—July 5, 1900. No. 35490 A.

Distributing Systems.

The Distribution of Electricity. G. Wilkinson. Abstract of a paper read before the Munic. Elec. Assn., England. Also editorial review. Calls attention to faults in systems in use. 2500 w. Elec Rev, Lond—July 6, 1900. No. 35290 A.

Earth Potential.

On the Maintenance of Certain Portions of Distributing Systems at Earth Potential. C. H. Wordingham. Read at Cardiff convention of Munic. Elec. Assn. Considers earth connections in various systems of transmission, and the manner the currents return through the earth, and whether it is best for any supply to be connected to earth. 5000 w. Elec Eng, Lond—July 20, 1900. No. 35585 A.

Induction.

Alternating-Current Induction Motors. A. C. Eborall. Read before the Inst. of Elec, Engs. Discusses points connected with the construction, design and performance of modern single and polyphase induction motors, and considers some recent developments. Ill. 3000 w. Elec Eng, Lond—July 20, 1900. Serial. 1st part. No. 35583 A.

Insulation.

Substitutes for India Rubber and Gutta Percha for Electrical Purposes. From the *Electro-Chemical Review*. Concerning compounds that may be used as substitutes for many uses. 1200 w. Am Gas Lgt Jour—July 9, 1900. No. 35174.

Losses.

The Reduction of Light-Load Losses in Alternating Supply Works. Horace Boot. Read at Huddersfield convention of the Munic. Elec. Assn. Considers works losses and distribution losses, and means of reducing them. Discussion. 4800 w. Elec Eng, Lond—July 6, 1900. No. 35408 A.

Polyphase.

The Polyphase Power Distributing System of the Deering Harvester Company. Illustrated description of an isolated plant unique on account of its size and its use of induction motors on a large scale. 5000 w. Am Elect'n—Aug., 1900. No. 35659.

Wire Protection.

The Protection of Telegraph and Telephone Wires in Connection with Overhead Traction. R. C. Quin. Read at Cardiff convention of Munic. Elec. Assn. Briefly considers the systems of protection in use. 1300 w. Elec Eng, Lond—July 20, 1900. No. 35587 A.

Wiring.

Free Wiring. E. E. Hoadley. A copy of the scheme worked out for the free wiring of the city of Worcester, Eng. 3500 w. Elect'n, Lond—June 22, 1900. No. 35091 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Manufacture of Electric Accumulators. The importance of purity of materials and methods of testing. 2000 w. Auto Jour—July, 1900. No. 35492 A.

Gas Polarization in Lead Accumulators (Ueber die Gas-polarisation im Bleiakkumulator). Dr. Strasser and Dr. Gahl. An article, giving the results of experiments with lead-antimony negative plates of various composition. 1000 w. Zeitschr f Elektrochemie—July 5, 1900. No. 35375 G.

Progress in the Development of Secondary Batteries in the Last Twenty-five Years (Fortschritte in der Entwickelung der Sekundärbatterien in den Letzten 25 Jahren). An historical review of slow but steady progress. Serial. 2 parts. 3500 w. Elektrochemische Zeitschr—June, July, 1900. No. 35377 each G.

Investigations of Battery Plates in Need of Repairs (Untersuchungen über Reparaturbedürftige Batterieplatten). J. K. Pumpelly. Photographs and descriptions of storage battery plates which had been in use for two months on motor vehicles in the streets of Chicago. 400 w. Elektrochemische Zeitschr—July, 1900. No. 35378 G.

Alkalies.

Anodes for Electrolytic Alkali Processes. A. T. Weightman. A statement of the difficulties met and remedies found. 2700 w. Eng & Min Jour—Aug. 4, 1900. No. 35699.

Calcium Carbide.

On Discontinuous and Continuous Carbide Furnaces (Ueber Diskontinuierliche und Kontinuierliche Carbidöfen). Dr. O. Fröhlich. A comparison and illustrated description of various forms of electric furnaces for producing calcium carbide. 4500 w. Zeitschr f Elektrochemie—July 5, 1900. No. 35374 G.

Electrolysis.

Electrolysis Without Electrodes (Elektrolyse ohne Elektroden). Rud. v. Heuser. An illustrated description of an apparatus in which the electrolyte circulates between magnet poles and so has currents induced in it. 2000 w. Elektrochemische Zeitschr—June, 1900. No. 35376 G.

See also same heading under Street and Electric Tramways.

ELECTRO-PHYSICS.

Cathode Rays.

On the Energy of the Cathode Rays. W. G. Cady. An investigation carried out at the Physical Inst. of the Univ. at Berlin. Ill. 3500 w. Am Jour of Sci—July, 1900. No. 35135 D.

Induction.

Improved Induction Coils. James Asher. Describes several simple methods of suppressing sparking without employing a condenser. 1500 w. W Elect'n—July 21, 1900. No. 35473.

Interrupter.

Alternating-Current Work with the Wehnelt Interrupter. Benjamin F. Bailey. Report of investigations made at the Univ. of Mich. 3300 w. Elec Wld & Engr—July 14, 1900. No. 35233.

Spectroscopic Observations with the Wehnelt Interrupter (Spektroskopische Beobachtungen am Wehnelt-Unterbrecher). Edm. Hoppe. A description of an apparatus for the steady observation of the spectra of metals and metallic salts in the Wehnelt spark. 1500 w. Elektrotech Zeitschr—June 21, 1900. No. 35311 B.

Magnetism.

The Action of Light on Magnetism. Joseph Hall Hart. An account of experimental investigations, with conclusions drawn from the results obtained. 2800 w. Am Jour of Sci—July, 1900. No. 35137 D.

Radiation.

The Best Known Theories of Röntgen Rays (Die Bekanntesten Theorien über das Wesen der Röntgenstrahlen). Dr. H. Schenkel. A general review of Röntgen ray theories. Serial. 2 parts. 3200 w. Elektrizität—May 26, June 9, 1900. No. 35385 each C.

Radio-Conductors.

The Increase in Resistance of Some Radio-Conductors (Accroissements de Résistance des Radioconducteurs). Ed. Branly. A short account of some experiments tending to confirm the opinion that the phenomenon is due to the physical state of the insulating layers between the conducting particles. 700 w. Comptes Rendus—April 17, 1900. No. 35396 D.

GENERATING STATIONS.

Central Station.

The Blackheath and Greenwich Electric Light Company's Central Station. Illustrates and describes a station for the supply of current for lighting and power in England. 2100 w. Engr, Lond—July 20, 1900. Serial. 1st part. No. 35628 A.

Dynamo.

Siemens-Halske Dynamo and Borsig Engine at the Paris Exposition (Groupe Electrogène, Machine à Vapeur Borsig et Alternateur Siemens et Halske). F. Loppé. An illustrated description of this 2,000-kilowatt polyphase generator, with characteristic curves. 2 plates. 1600 w. Electricien—July 7, 1900. No. 35562 B.

Siemens-Halske Dynamo and Borsig Engine of 2,500 Horse-Power at the Paris Exposition (Exposition de 1900. Groupe Electrogène de 2,500 Chevaux Borsig et Siemens et Halske). Ch. Dantin. A well illustrated description of this great generating unit in the German section of Machinery Hall. 1 plate. 1800 w. Génie Civil—June 16, 1900. No. 35387 D.

Rotary-and Alternating Current Generator of the Helios Company (Dreh-und Wechselstromgenerator des Helios, Elektricitäts-A.-G.). An illustrated description of this large dynamo in the German section of Machinery Hall at the Paris Exposition. 1600 w. Elektrotech Zeitschr—June 21, 1900. No. 35309 B.

Schuckert Direct Current and Rotary Current Generators at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Gleichstrom-und Drehstrom-Generatoren der Elektrizitäts—A. G. vorm. Schuckert & Co. in Nürnberg). An illustrated description of two large Schuckert dynamos directly coupled to a 2,200 horse-power engine. 500 w. Elektrotech Zeitschr—July 12, 1900. No. 35320 B.

The 4,000 Horse-Power Rotary Current Dynamo of the Allgemeine Elektricitäts Gesellschaft at the Paris Exposition (Die 4,000 Pferdige Drehstrom-Dynamomaschine der A. E. G. auf der Weltausstellung in Paris). A short description, with photographic illustrations. 400 w. Ill Zeitschr f Klein u Strassenbahnen—July 1, 1900. No. 35384 C.

Dynamo Design.

The Designing and Testing of Dynamos and Motors (Beiträge zur Berechnung und Beurtheilung von Dynamomaschinen und Motoren). Dr. F. Niethammer. A discussion, partly mathematical, of the design of dynamos and motors, with diagrams. Serial. 2 parts. 3200 w. Elektrotech Zeitschr—June 28, July 5, 1900. No. 35314 each B.

Germany.

Review of German Central Station Statistics (Rundschau). Editorial review of the statistics of the public central stations in Germany on March 1, 1900. 2800 w. Elektrotech Zeitschr—July 5, 1900. No. 35317 B.

German Central Station Statistics (Statistik der Elektricitätswerke in Deutschland nach dem Stande vom 1 März, 1900). General statistical tables of all the public central stations in Germany, either in operation or in course of construction on March 1, 1900. 10000 w. Elektrotech Zeitschr—July 5, 1900. No. 35316 B.

Gloucester.

Gloucester Electricity Works. Illustrated detailed description of plant. 4500 w. Elec Eng, Lond—July 20, 1900. No. 35582 A.

Paris Exposition.

The Central Station for Power and Light at the Paris Exposition (Die Pariser Weltausstellung III. Die Kraft-und Lichtcentrale). An illustrated description of some of the features of Machinery Hall on the Champ de Mars. 3000 w. Stahl und Eisen—May 15, 1900. No. 35326 D.

Power Plant.

The Power Plant of the New York Factory of the Western Electric Company. An illustrated description of a fine isolated plant, probably the largest delivering its output to one building in the world. 2500 w. Am Elect'n—July, 1900. No. 35179.

Power-Station Design.

Some General Conditions Governing Power Station Design. Philip Dawson. Read before the Tramways and Light Rys. Assn. Considers the question from the economical point of view, calling attention to the differences in a station designed for lighting, and one designed for traction. 2000 w. Elec Rev, Lond—July 6, 1900. No. 35292 A.

Construction of a Large Power-House Building. Illustrated description of the methods followed by the builders of the 70,000 H.-P. station of the Metropolitan Street Railway Co., New York. 2000 w. Eng Rec—July 28, 1900. No. 35611.

Power Station of the Northwestern Elevated Railroad, Chicago. Illustrates and describes a recently built plant, embodying the latest and best practice in all that is conducive to economical operation. 3000 w. St Ry Rev—July 15, 1900. No. 35433 C.

Prague.

The Electric Central Station at Prague (Die Elektrische Central-station in Prag). Emil Kolben. A long illustrated description of this large central station, which furnishes polyphase current for tramways, power and lighting. 6000 w. Elektrotech Zeitschr—June 28, 1900. No. 35313 B.

St. Helens.

Destructor and Electric Power Station at St. Helens. J. S. Highfield. A short account of the works and results obtained in a combination destructor and electric supply plant which has been working six months. 900 w. Elec Rev, Lond—July 6, 1900. No. 35291 A.

Sao Paulo.

The Sao Paulo Power Plant, Brazil. Illustrated description of an 8,000 H.-P. hydraulic plant for a Brazilian city where coal sells at $10 a ton, making an elaborate station financially advisable. 2300 w. Eng Rec—July 21, 1900. No. 35456.

Savoy.

Hydro-Electric Power Plant at La Praz, Savoy (Usine Hydro-Electrique de la Praz, Savoie). A. Lapouche. An illustrated description of this plant, whose current is used to produce aluminium. An arched steel water pipe serves as a foot-bridge of 50 meters span. 1500 w. Génie Civil—June 23, 1900. No. 35390 D.

Small Stations.

Diverse Service from Small Stations. Alton D. Adams. Discusses the equipment that will best serve the needs of such stations. 1500 w. Elec Rev, N. Y.—July 18, 1900. No. 35427.

Switchboards.

Switchboards and Switches of the Modern Central Station. E. W. Rice, Jr. Extract from a paper read before the Gen. Elec. Engng. Soc. of Schenectady. A discussion of methods, with suggestions. 2400 w. Elec Wld & Engr—June 30, 1900. No. 35126.

Transformers.

Design for a Simple Transformer in Four Sizes. Cecil P. Poole. Illustrates and describes transformers that can be built by any amateur without the use of machine tools. 1200 w. Am Elect'n—July, 1900. No. 35180.

LIGHTING.

Arc Lamps.

The Choice of Arc Lamps. Wilbur M. Stine. Discusses the properties of such lamps, and their adaptability, efficiency and cost of installation and operation. 4000 w. Am Elect'n—July, 1900. No. 35178.

Differential Arc Lamp with Recoil Mechanism for Continuous and Alternating Currents, on the Bardon System (Lampe Différentielle à Mécanisme de Recul pour Courants Continu et Alternatif Système Bardon). M. Aliamet. An illustrated description of arc lamp mechanism. 1400 w. Electricien—May 26, 1900. No. 35552 B.

The Bremer Electric Light System (Das Neue Elektrische Licht System Bremer). W. Wedding. A paper before the Verband Deutscher Elektrotechniker, giving the results of experiments on the Bremer arc lamp, in which the carbons contain metallic salts, such as calcium and magnesium compounds. With curves and tables. 2000 w. Elektrotech Zeitschr—July 5, 1900. No. 35318 B.

Electric Decoration.

The Crest of the Palace of Electricity. From *L'Illustration.* Illustrated description. 1200 w. Sci Am Sup—July 14, 1900. No. 35240.

Electric Tower.

The Pan-American Electric Tower. Illustrated description of the general arrangement of the grounds of the Pan-American Exposition at Buffalo and of its leading feature—an electric tower 375 feet high, explaining a number of the special structural details. 1500 w. Eng Rec —July 21, 1900. No. 35457.

Incandescent Lamp.

The Incandescent Lamp. Ed. C. De Segundo. Discusses the way in which energy is dissipated in an electric incandescent lamp, its efficiency, the improvements made, etc. 1800 w. Elec Rev, Lond—July 20, 1900. Serial. 1st part. No. 35589 A.

A Baseless Incandescent Lamp (Suppresion du Culot dans les Lampes à Incandescence). J. A. Montpellier. An illustrated description of the Hollub lamp, in which metallic terminals are attached directly to a glass projection at the bottom of the bulb. 700 w. Electricien—July 7, 1900. No. 35563 B.

Nernst Lamp.

Nernst Lamp Patents. An account of patents on details of the Nernst lamp system, interesting in showing the difficulties in its commercial development 3300 w. Elec Wld & Engr—July 7, 1900. No. 35173.

Small Towns.

Electricity Supply for Small Towns. Papers by C. S. Vesey Brown and G. M. Harris, read at the Huddersfield convention of the Munic. Elec. Assn. Discusses the system. 5500 w. Elec Engr, Lond—June 22, 1900. No. 35087 A.

Street Lighting.

Street Lighting. H. H. Wait. Abstract of paper read before the Northwestern Elec. Assn. Discusses the cost of arc lighting and the relative economy of open and enclosed arc lamps. 1900 w. Am Elect'n—Aug., 1900. No. 35661.

Train Lighting.

Electric Lighting of Railway Trains. George D. Shepardson. An illustrated account of the "Burlington Limited" train and its lighting and electrical features. It has been in service three years. 3500 w. Elec Wld & Engr—July 7, 1900. No. 35172.

See also Railway Affairs, Equipment.

MEASUREMENT.

Dynamometer.

The Leneveu Rotary Recording Dynamometer (Dynamomètre de Rotation Enregistreur de M. le Capitaine Leneveu). A well illustrated description of a transmitting and registering dynamometer. 5000 w. Rev de Mécanique—May 31, 1900. No. 35569 E + F.

Galvanometer.

A Universal Measuring Instrument for Telegraph Circuits (Ueber ein Universalmessinstrument für Telegraphenleitungen). Dr. F. Breisig. Paper before the Elektrotechnischer Verein describing a convenient form of galvanometer for telegraph testing work, with illustration and diagrams. 3200 w. Elektrotech Zeitschr —June 28, 1900. No. 35315 B.

Indicating Instruments.

Electrical Measuring Instruments. J. Franklin Stevens. A discussion of commercial direct reading indicating instruments, such as are found in every-day use, and the requirements. 7000 w. Jour Fr Inst—July, 1900. No. 35161 D.

Indicator.

Electric Indicator for Determining the Relative Position of the Cranks of Engines in Operation (Elektrischer Indikator zur Bestimmung der Relativen Kurbellage Laufender Maschinen). P. v. Kowaleff. An illustrated description of an apparatus, consisting of a voltmeter in circuit with commutators and a source of current, which indicates the relative position of the cranks of engines driving alternating and rotary current dynamos. 700 w. Elektrotech Zeitschr—June 21, 1900. No. 35310 B.

Photometry.

On the Photometry of Arc Lamps. F. W. Carter. Gives results of experience in testing, showing how to carry out the tests, and giving details of devices for overcoming the difficulties and placing the results on a rational basis. Ill. 1600 w. Elec Rev, Lond—July 13, 1900. Serial. 1st part. No. 35475 A.

Rotary Current.

Rotary Current Meters (Ueber Drehstrom-Zähler). J. A. Möllinger. A mathematical discussion of rotary current wattmeters. Serial. 1st part. 3000 w. Elektrotech Zeitschr—July 12, 1900. No. 35319 B.

Traction.

Traction Meter for Electric Cars (Zugkraftmesser für Elektrische Bahnwagen). Gisbert Kapp. A paper before the Verband Deutscher Elektrotechniker, giving the theory and a description of a simple apparatus, consisting of a horizontal tube with vertical legs, in which the height of liquid in one of the legs indicates the tractive force. With diagram and illustration. 1200 w. Elektrotech Zeitschr—July 12, 1900. No. 35321 B.

POWER APPLICATIONS.

Automobile.

See Mechanical Engineering, Automobilism.

Canal Haulage.

Electric Traction on Canals in Belgium. Illustrated description of the system of M. Gérard, installed between Brussels and Charleroi. 1500 w. Tram & Ry Wld—July 5, 1900. No. 35487 A.

Cripple Creek.

Electric Power in Cripple Creek District. J. W. Dickerson. Illustrated description of the generating equipment, steam plant, and electrical features. 1000 w. Mod Mach—July, 1900. Serial. 1st part. No. 35121.

Electric Elevator.

The Electric Elevator for Cars at the Custom House Railway Station in Vienna (Die Elektrischen Waggonhebewerke am Bahnhof Hauptzollamt in Wien). Anton Freissler. An address before the Oest. Ing. und Arch, Verein, giving an illustrated description of elevators for lifting freight cars from the track level 19 feet to the main floor of the custom house. 3500 w. Zeitschr d Oest Ing u Arch Ver—June 1, 1900. No. 35342 B.

Electric Hoisting.

The Electric Hoisting Plant of the Thiederhall Company at Thiede, near Brunswick (Die Elektrische Förderanlage der Aktien-Gesellschaft Thiederhall in Thiede bei Braunschweig). Prof. O. Hoppe. The current is generated above ground and an electric motor 300 meters underground drives the rope hoist from the 500 meter level. Illustrated. 4000 w. Glückauf—June 9, 1900. No. 35350 B.

Electric Pump.

A New Form of Electric Pump for Underground Use. Emerson Bainbridge. Read before the Brit. Inst. of Min. Engs. Describes the Hatfield Electric Pump, stating its advantages. 900 w. Col Guard—June 22, 1900. No. 35117 A.

Electric Turrets.

The Schneider-Canet Electric Turrets (Les Tourelles Electriques Schneider-Canet). Geo. Dary. A general description of electric mechanism for moving turrets and big guns on men-of-war. 1200 w. Electricien—June 16, 1900. No. 35-559 B.

Mining Machinery.

Electric Mining Machinery in the British Collieries. Sydney F. Walker. A richly-illustrated review; this part is devoted to machinery for coal-cutting, pumping, and mine haulage. 3800 w. The Engineering Magazine—Aug., 1900. No. 35637 B.

Motor Applications.

Some Notes on the Application of Motors in an Iron and Steel Plant. Illustrates and describes interesting heavy applications in operation at the National Steel Co.'s works at Youngstown, Ohio. 3000 w. Elec Wld & Engr—July 14, 1900. No. 35232.

Motors.

I. Power Supply by Single-Phase Motors. T. P. Wilmshurst. II. Notes on the Maintenance of Motors on Hire from an Electricity Works. C. A. L. Prussman. Two papers read before the Huddersfield Convention of the Munic. Elec. Assn. and discussed together. 7800 w. Elec Eng, Lond—June 29, 1900. No. 35-214 A.

Oculist.

Electro-Magnet Extractor for Oculists (Electro-Aimant Extracteur pour Oculistes). M. Aliamet. A brief illustrated description of a powerful electro-magnet for extracting bits of iron from eyes. 250 w. Electricien—June 23, 1900. No. 35-561 B.

Printing Plant.

Electrical Equipment of the Printing Plant of the St. Louis *Republic*. Illustrated description. 1700 w. Eng News—July 5, 1900. No. 35182.

TRANSMISSION.

Copper Saving.

Copper Saving in the Joint Transmission of Direct and Alternating Currents. Frederick Bedell. Abstract of a paper read at N. Y. meeting of the Am. Assn. for the Adv. of Science, with editorial. A mathematical discussion of the problem, with editorial on the practical application. 3000 w. Elec Wld & Engr—June 30, 1900. No. 35127.

MISCELLANY.

Address.

The Municipal Electrical Association Presidential Address by Mr. A. B. Mountain, at Huddersfield. Discusses the work of the association. 3300 w. Elect'n, Lond—June 22, 1900. No. 35090 A.

Bombay.

Electric Works in Bombay. Copy of the agreement which it is proposed should be adopted by any firm to whom permission for electric supply is granted. 1700

w. U. S. Cons Repts, No. 774—July 7, 1900. No. 35154 D.

Electrical Congress.

International Electrical Congress (Congrès International D'Electricité). The provisional program of the congress, which meets August 18 to 25, at the Paris Exposition. 1400 w. Electricien—June 9, 1900. No. 35558 B.

Lessons.

Lessons in Modern Electrical Engineering. The first of a series of articles reviewing progress since 1890, and facts to be remembered. 1800 w. Builder—July 7, 1900. Serial. 1st part. No. 35294 A.

Liabilities.

The Common Law Liabilities of Electrical Undertakings. A summary illustrating the more important rules which must guide in negotiations with the public in England. 2200 w. Engng—July 6, 1900. No. 35280 A.

Lightning Rods.

Discussion of Regulations for the Protection of Buildings against Lightning, drawn up by a Committee of the Elektrotechnischer Verein (Antrag des Technischen Ausschusses auf Annahme der "Leitsätze über den Schutz der Gebäude gegen den Blitz" durch den Elektrotechnischen Verein). Discussion at a meeting of the Verein, opened by K. Strecker. 11000 w. Elektrotech Zeitschr—July 12, 1900. No. 35322 B.

Paris Exposition.

Opening of the U. S. Sections in Electricity Building, Paris Exposition. An account of the opening and plans of the American Court of Honor, with illustrations. 2000 w. Elec Wld & Engr—June 30, 1900. No. 35124.

GAS ENGINEERING

Acetylene.

The Use of Acetylene in Railway Station and Train Lighting. A. Lipschutz. Describes its use for station lighting and gives details of a plant in practice. Also considers its adaptability to train lighting. 6500 w. Jour Assn of Engng Socs —June, 1900. No. 35402 C.

Address.

President's Address at the Annual Meeting of the Society of Chemical Industry, London. Abstract. Deals with technical education, water gas, incandescent gas mantles, and other topics. 4000 w. Jour Gas Lgt—July 24, 1900. No. 35652 A.

Benches.

The Use of Crude Petroleum for Firing Benches. R. M. Powers. Read before the Pacific Coast Gas Assn. On the employment of oil as a fuel under benches. Also general discussion. 3700 w. Am Gas Lgt Jour—Aug. 6, 1900. No. 35709.

Boston, Mass.

The Gas Supply of Boston, Mass. J. H. Gray, in *Quarterly Journal of Economics*. Abstract showing American financial methods as applied to gas undertakings. 1800 w. Jour Gas Lgt—July 10, 1900. Serial. 1st part. No. 35483 A.

Coal Tars.

The Composition of Some Coal Tars from American Gas-Works. Alfred H. White and H. W. Hess. Read before the N. Y. section of the Soc. of Chem. Ind. Explains the reasons for the feeble condition of the coal-tar industry in America, giving results of analyses. 1800 w. Jour Gas Lgt—July 17, 1900. No. 35528 A.

Fuel.

Twentieth Century Energy. Alton D. Adams. Arguing that gas and electricity are the forms of energy that will prevail. 2200 w. Sci Am—July 14, 1900. No. 35238.

Gas Manufacture.

Modern Methods of Manufacturing Gas; With a Description of Its Distribution under High Pressure. Frederick H. Shelton. Reviews the processes, and their advantages and disadvantages, and advocates high pressure distribution. Also discussion of the paper. 4800 w. Pro Engs' Club of Phila—July, 1900. No. 35276 D.

London.

The Price of Gas in London. Abstract of a memorandum on the increase of charges made by gas companies, due to the high price of coal. 2000 w. Engr, Lond—July 20, 1900. No. 35629 A.

The Gas Supply of the Metropolis. On the bills before the English Parliament. 2000 w. Engr, Lond—July 6, 1900. Serial. 1st part. No. 35412 A.

Wood Gas.

The Riché Gas Apparatus (Les Gazogènes Riché). P. Corbier. An illustrated description of this apparatus for producing gas from wood, to be used principally for power and heating purposes. 2500 w. Génie Civil—June 30, 1900. No. 35393 D.

MARINE AND NAVAL ENGINEERING

Balanced Rudders.

The Distribution of Pressure Due to Flow Round Submerged Surfaces, with Special Reference to Balanced Rudders. H. S. Hele-Shaw. Read before the Inst. of Nav. Archts., England. On the manner of investigating the relative distribution of the pressure. Ill. 2700 w. Engng—July 13, 1900. Serial. 1st part. No. 35505 A.

Bilge-Keels.

The Steadying of Ships. G. H. Bryan. Describes investigations made, showing that the efficiency of bilge-keels in modifying the rolling of ships may be greatly increased by the action of the sides of the ship itself. Abstract of paper read before the Inst. of Nav. Archts, 1800 w. Nature—June 21, 1900. No. 35086 A.

Cable Steamer.

The Cable-Laying Steamer "Von Podbielski." Illustrated description of Germany's first cable-laying steamer, and its equipment. 3000 w. Engng—June 22, 1900. No. 35113 A.

Cruiser.

Russian Cruiser "Variag." Illustration and brief description of vessel built in the United States for Russia. 300 w. Marine Rev—July 5, 1900. No. 35167.

Deutschland.

The Hamburg-American Liner "Deutschland." Remarks on recent progress in steamship construction with illustrations and interesting features of the vessel named. 1500 w. Sci Am—Aug. 4, 1900. No. 35649.

Dredges.

Dredges on the Mississippi. Waldon Fawcett. Brief illustrated descriptions of some of the dredges used. 1500 w. Sci Am—July 7, 1900. No. 35132.

Excursion Boat.

Elegant Western River Excursion Packet. Illustration and description of the new steamboat "Francis J. Torrance," built for service at Pittsburg. 2000 w. Naut Gaz—July 26, 1900. No. 35547.

Ferryboats.

The Harbor Ferryboats of 1850. Reprint of an article appearing in the *N. Y. Herald* on July 2, 1850, giving a correct list of the boats and the companies operating, and interesting facts of vessels in N. Y. harbor. 2000 w. Naut Gaz—July 26, 1900. No. 35548.

Hoboken Fire.

Hoboken's Holocaust. An account, with editorial comment, of the terrible fire that destroyed the North German Lloyd's piers and vessels. 5000 w. Fire & Water—July 7, 1900. No. 35158.

The Burning of the North German Lloyd Steamships and Docks, Hoboken, N. J. An illustrated account of this disaster, with editorial comment. 3000 w. Sci Am—July 14, 1900. No. 35237.

The Lessons of the New York Harbor Fire. Editorial briefly describing the conditions at the fire which destroyed the piers and steamships of the N. German Lloyd Co. at Hoboken, and commenting on steps needed to avert a repetition of the catastrophe. 2200 w. Eng News—July 14, 1900. No. 35256.

See also Wharf under Civil Engineering, Construction.

Marine Boilers.

The Making and Testing of Several Types of Marine Boilers (Ausführung und Erprobung einiger Schiffskesseltypen). H. Görris. A review of the subject, with particular reference to tests and experiments made on boilers of British naval vessels. Illustrations and tables. Serial. 2 parts. 9000 w. Zeitschr d Ver Deutscher Ing—June 30, July 7, 1900. No. 35303 each D.

Propulsion.

Direct Application of Electricity to the Propulsion of Ships. William F. Durand. A reply to certain of the statements made by Nikola Tesla in the June, 1900, issue of *The Century Magazine*. 2800 w. Marine Engng—July, 1900. No. 35205 C.

Improvements in Screw Propulsion. I. McKim Chase. Considers methods of utilizing the discharged water from a screw propeller to aid propulsion. 1000 w. Marine Rev—July 5, 1900. No. 35168.

Schooner.

A Famous Old Schooner. From the Boston *Evening Transcript*. Reviews the history of the "Polly, of Calais, Me." in service ninety-six years. 1400 w. Marine Rev—July 12, 1900. No. 35235.

Shafts.

How the Shaft of the Transport "Fazilka" was Repaired. Illustrated description of the repair of a shaft fractured in two places inside the stern tube, forcing itself through the tube. 1000 w. Engr, Lond—June 29, 1900. No. 35216 A.

Ship-Building.

The Ship Building Yards of the United States. Waldon Fawcett. A continuation of a former paper. Reviews the location, growth, equipment, and output of the principal yards of the coast and the lakes. Very fully illustrated. 4000 w. The Engineering Magazine—Aug., 1900. No. 35633 B.

A Short Account of Some of the Changes Which Have Been Introduced into the Types, Sizes and Construction of Ships During the Last Forty Years. B. Martell. Abstract of a paper read before the Inst. of Naval Archts. 4000 w. Engs' Gaz—July, 1900. No. 35213 A.

Progress of Warships and Machinery Building in England. Notes on the progress of work now in hand in English ship yards and marine engine works. 3400 w. Engr, Lond—June 29, 1900. No. 35215 A.

Bath Iron Works, Ltd. A sketch of its history and an illustrated description of the plant. 3300 w. Marine Rev—July 19, 1900. No. 35467.

Steamboats.

New York's Passenger Steamboats of 1850. Illustrated review of the Sound and river boats of fifty years ago. 2800 w. Naut Gaz—July 12, 1900. Serial. 1st part. No. 35259.

Twin-Screw Steamboat "Pennsylvania," Built for the Cape Charles Route. Illustration, plans and cross sections, with detailed description. 2400 w. Marine Engng—July, 1900. No. 35204 C.

Steamship.

A New Atlantic Liner. Describes the twin-screw steamer "Vaderland," of the Red Star service. 2500 w. Engng—July 13, 1900. No. 35504 A.

New Coast Steamship. Illustration and description of the "Grecian," built for the Boston and Philadelphia route. 2000 w. Naut Gaz—July 12, 1900. No. 35258.

Ocean Steamers Plying Out of New York Fifty Years Ago. An illustrated description of the types of ocean steamers in service in 1850. 3000 w. Naut Gaz—July 19, 1900. No. 35469.

The Twin-Screw Channel steamer "Alberta." Illustrated description of a steamer especially built for the Paris Exposition traffic between Southampton and Havre. 1600 w. Engng—July 13, 1900. No. 35502 A.

Torpedo Vessels.

Are the Last Knots of Speed in Torpedo Vessels Worth Their Cost? Editorial discussion claiming that it has not yet been demonstrated that phenomenal bursts of speed in these vessels will be of value in actual warfare. 2200 w. Eng News—July 5, 1900. No. 35185.

Transportation.

Ocean Transportation to Eastern Asia. Eugene T. Chamberlain. The importance of improved facilities for ocean transportation is shown. 2000 w. N Am Rev—July, 1900. No. 35155 D.

Tugs.

Fine New Coast Tug. Illustrates and describes the new sea-going tug-boat "Abram Minis." 1800 w. Naut Gaz—July 19, 1900. No. 35468.

Turrets.

Gruson Rotating Turrets. T. Guilford Smith. Illustrates and describes the construction and merits of this class of gun-protection. 2300 w. Trans Am Inst of Min Engs—June, 1900. No. 35515 D.

Water-Tubes.

Water-Tube Boilers in Warships. Tabulated lists of the principal types used, or to be used, in warships, with remarks. 900 w. Engr, Lond—July 13, 1900. No. 35506 A.

Belleville Boilers. Editorial on the debate in the House of Commons, and the Admiralty Memorandum Respecting Water-Tube Boilers in H. M. ships. 4500 w. Engng—July 20, 1900. No. 35573 A.

Mr. Goschen's Memorandum on Water-Tube Boilers. A statement dealing with ships fitted with Belleville boilers, or with boilers of large tube types. 7500 w. Engr, Lond—July 20, 1900. No. 35630 A.

Yacht.

A Yacht That Sails Itself. Illustrated description of the little model yacht "Nydia," which is automatically controlled. 1400 w. Sci Am—July 28, 1900. No. 35530.

Yacht Plumbing.

The Ellis System of Yacht Plumbing. Illustrated description of the plumbing which has been installed in the steam yacht "Saghaya." A cesspool tank is used which empties automatically. 900 w. Met Work—July 21, 1900. No. 35435.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electric Phaeton.

Working Drawing of an Electric Phaeton. From *The Hub*. Full explanation of drawing. 2800 w. Sci Am Sup—July 14, 1900. No. 35241.

Evolution.

The Evolution and Present Status of the Automobile. William Baxter, Jr. Historical review dating back to the middle of the sixteenth century, and illustrating many early vehicles. 3000 w. Pop Sci M—Aug., 1900. No. 35537 C.

Heavy Vehicles.

Heavy Motor Vehicles for Road Service. Fred M. Maynard. Gives valuable data of cost, compared with railway, canal, and horse haulage, and discusses the essential principles of design of heavy wagons. Serial. 1st part. 3600 w. The Engineering Magazine—Aug., 1900. No. 35639 B.

Imperfections.

Automobile Imperfections. W. H. Booth. Compares the automobile with the horse, and shows the need of wheel guards when the horse is no longer used. 1200 w. Am Mach—July 26, 1900. No. 35526.

Locomobile.

A Locomobile with Compound Engine (Machine Compound Demi-Fixe à Faisceau Tubulaire Amovible). An illustrated description of this locomobile, made by Wolf, of Magdeburg, in which the engine cylinders are placed in the steam dome on top of the boiler. 700 w. Génie Civil—June 23, 1900. No. 35391 D.

Mechanical Propulsion.

The Recent Trials of Motor Vehicles. H. S. Hele-Shaw. Supplementary paper to the one on "Road Locomotion," read before the Inst. of Mech. Engs. 1200 w. Horseless Age—July 18, 1900. No. 35298.

Paris Exhibition.

Automobile Carriages at the Paris Exhibition. The first of a series of articles describing the large and important collection of exhibits. 2200 w. Engr, Lond—July 20, 1900. Serial. 1st part. No. 35626 A.

Electric Automobiles at the Paris Exposition. Illustrates and describes some of the vehicles on exhibition. 2800 w. Elec Wld & Engr—July 14, 1900. No. 35234.

HYDRAULICS.

Riedler Pump.

Riedler Express Pumps (Riedler-Expresspumpen). Prof. Karl Habermann. An illustrated description of these high-speed pumps, which are often directly coupled to electric motors, with a list of pumps installed in Germany, Austria and Denmark. 1 plate. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 23, 1900. No. 35357 B.

Water Power.

On Water Powers, with Particular Reference to the Utilization of the Power of the "Gesäuse" Cataract, in Styria (Ueber Wasserkräfte, insbesondere über die Ausnützung der Wasserkraft im Gesäuse). Dr. P. Forchheimer. Abstract of an address at the Polytechnic Club, Gratz, with table of Swiss improved water powers, and plans for using the Gesäuse water power. 1200 w. Wiener Bauindustrie Zeitung—June 21, 1900. No. 35368 D.

MACHINE WORKS AND FOUNDRIES.

American Competition.

Has the German Mechanical Industry Anything to Learn from the American (Kann die Deutsche Maschinenindustrie von der Amerikanischen Lernen)? H. Unger. A paper before the Verein Deutscher Maschinen-Ingenieure, discussing American competition in Germany and giving illustrated descriptions of American machine tools. Serial. 1st part. 6000 w. Glaser's Annalen—July 1, 1900. No. 35324 D.

Arrangement and Design.

Lugansk and the Hartmann Machine Company's Locomotive Works. Illustrated description of a model locomotive factory. 2200 w. Engr, Lond—July 6, 1900. No. 35414 A.

New Works of the English Electric Manufacturing Company, Limited. An illustrated detailed description of a large plant and its equipment. 5000 w. Tram & Ry Wld—July 5, 1900. No. 35485 A.

The New Works of the English Electric Manufacturing Co. at Preston. An illustrated detailed description of the shops and their equipment, with account of the organization of the company. 4200 w. Elect'n, Lond—June 22, 1900. No. 35089 A.

Castings.

Casting a Double-Thread Worm. L. C. Jewett. Sketch and brief description showing a method of molding a double-threaded worm to be cast vertically and without joint seams. 400 w. Am Mach—July 5, 1900. No. 35171.

The Steel Castings Industry of To-day. M. A. Tissot. Read before the Min. & Met. Cong. at Paris. Reviews the improvements that have made possible the success. 1000 w. Ir Trd Rev—July 12, 1900. No. 35243.

Dies.

Two Forming Dies. A. H. Cleaves. Illustrated description. 400 w. Am Mach—July 26, 1900. No. 35527.

Gear-Teeth.

The Fellows Machine and Cutter for Generating Gear-Teeth. Report of the Franklin Inst. committee, investigating the invention of E. R. Fellows. Ill. 2500 w. Jour Fr Inst—Aug., 1900. No. 35591 D.

Guns.

Notes on the Construction of "Long Cecil," a 4.1-Inch Rifled Breechloading Gun, in Kimberley During the Siege 1899-1900. Edward Goffe. 4 plates. Describes the construction. 5500 w. Inst of Mech Engs—1900. No. 35198 D.

Ladle Carriage.

Carriage for a Ladle of 20 Tons' Capacity (Giesspfannenwagen für 20,000 kg Pfanneninhalt). An illustrated description of two carriages, one operated by steam and hydraulic power, the other electrically, for transporting and pouring ladles containing molten metal. 800 w. Stahl und Eisen—June 15, 1900. No. 35335 D.

Machine Tools.

Machine Tools at the Paris Exposition (Die Weltausstellung in Paris, 1900, Werkzeugmaschinen). Hermann Fisher. A general review of the machine tool exhibits at the Exposition. Serial. 1st part. 3500 w. Zeitschr de Ver Deutscher Ing—July 7, 1900. No. 35306 D.

Criticisms on the General Construction of Machine Tools. A. R. Bellamy. Read before the Manchester (Eng.) Assn. of Engs. 4500 w. Am Mach—July 5, 1900. No. 35169.

Molding.

Molding a Lathe Bed. L. C. Jewett. Illustrates and describes a method of doing this work. 1000 w. Am Mach—July 5, 1900. No. 35170.

Percussive Tool.

An Inertia Valve Percussive Tool. Chester B. Albree. States the advantageous qualities of compressed air over steam, gives an outline of the development of percussive engines, and a description of the type named in the subject, with a discussion of some of the features in its design. Ill. 7000 w. Pro Engs' Soc of W. Penna—May, 1900. No. 35430 D.

Premium Plan.

The Determination of Time Limits Under the Premium Plan. George H. Hall. Discusses the importance of the proper establishment of the basis, showing how limits are determined in one shop and the means by which the data for their establishment are determined. 1600 w. Am Mach—July 12, 1900. No. 35201.

Pulleys.

Keys and Split Hubs. Illustrates and describes some methods of keying pulleys to their shafts. 1200 w. Mach, N. Y.—July, 1900. No. 35129.

Sheet Metal.

A Job in Drawing and Forming Sheet Metal. Joseph V. Woodsworth. Illustrated detailed description of the work. 600 w. Am Mach—July 12, 1900. No. 35203.

Springs.

Flat Springs. Robert A. Bruce. Discusses what design will secure the best economy of material, and gives a table to enable designers to settle the dimensions of a given spring with the minimum amount of trouble. 1500 w. Am Mach—July 19, 1900. No. 35431.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Part 3 of Prof. Diemer's series deals with storeroom management—location and arrangement of the room, section store-rooms, reservation of special orders, forms of rcord and report. 3400 w. The Engineering Magazine—Aug., 1900. No. 35636 B.

POWER AND TRANSMISSION.

Bearings.

Ball Bearings. D. T. Randall. Notes on the number and size of balls to be used. 2200 w. Mach, N. Y.—July, 1900. No. 35130.

Compressed Air.

Compressed Air Plant at Ainsworth, B. C. Illustrated detailed description of a plant run by compressed air derived direct from falling water. 2200 w. B. C. Min Rec—July, 1900. No. 35242 C.

A New Device for Reheating Compressed Air for Use in Pumps. E. A. Rix. Illustrates and describes this device for increasing efficiency. 1000 w. Compressed Air—July, 1900. No. 35405.

Applications of Compressed Air in Railroad Shop Practice. Edward C. Schmidt. From an address before the St. Louis Ry. Club. Gives figures relating to saving in time and labor, and describes uses to which it is applied. 1800 w. Compressed Air—July, 1900. No. 35404.

Flying Machine.

The Building of the Kress Flying Machine (Ueber den Bau des Kress 'chen Drachenfliegers). W. Kress. An address before the Oest. Ing. und Architekten Verein, giving a report of progress in the construction of this aeroplane machine. 1200 w. Zeitschr d Oest Ing u Arch Ver—June 15, 1900. No. 35344 B.

Lubrication.

A Few Suggestions on the Use and Abuse of Lubricants. C. Going. On the waste due to the use of automatic oiling devices, and to needless use of fluid lubricants, the materials used, etc. 1200 w. Marine Engng—July, 1900. No. 35206 C.

The "Oiliness" of Lubricating Oils. An argument, quoting from various authors, and favoring capillarity and adhesiveness as factors of efficient lubrication. 4000 w. Engr, Lond—June 22, 1900. No. 35109 A.

Mechanical Handling.

Mechanical Handling of Ore and Coal (Mechanische Handhabung von Erzen und Kohlen). H. Frahm. A long illustrated article giving an account of American methods and apparatus for conveying and handling ore and coal. Serial. 1st part. 3500 w. Stahl und Eisen—May 15, 1900. No. 35325 D.

Motive Power.

The Harnessing of Bacchus. An articles on the application of alcohol to power purposes. 1500 w. Auto Jour—July, 1900. No. 35493 A.

Power Development.

See same title under Steam Engineering.

Power Plants.

The Borsig Triple-Expansion Engine at the Paris Exposition. Illustrated description of the principal features of a marine type, four-cylinder engine and alternating generator direct-connected to it. 1500 w. Eng Rec—July 14, 1900. No. 35247.

Shafting vs. Electricity.

Power Transmission by Shafting vs. Electricity. Abstract of a committee report presented at the convention of the Am. Mas. Mechs.' Assn., concluding that the latter is more effective in large shops. 5800 w. Eng News—July 12, 1900. No. 35253.

Steam Hammers.

Variation in Steam Hammer Design and Cost—German and American. Henry Hess. Shows graphically various relations, and compares designs and costs. 600 w. Am Mach—July 12, 1900. No. 35202.

SPECIAL MOTORS.

Compressor Explosions.

Explosions and Ignitions in Air Compressors and Receivers. Alfred George White. Excerpt transactions Inst. C. E. An account of an explosion, with a description of the compressor, and the writer's explanation of the cause. 1600 w. Compressed Air—July, 1900. No. 35406.

Gas Engine.

The Gas Engine in Practical Use. J. D. Lyon. Reviews the development of the gas engine and its increasing use as a factor in the production of power. Ill. 3800 w. Pro Engs' Soc of W Penna—April, 1900. No. 35428 D.

Gas Engines for Tramway Power Stations. Explains the fundamental principles of the gas engine, and gives facts and information concerning their application to the working of tramways and light railways. Ill. 4800 w. Tram & Ry Wld—July 5, 1900. No. 35489 A.

Gas Engines and the Economy of Gasoline Engines for Small Power. John Wilkes. Read before the Engng. Assn. of the South. Considers the design, construction and operation of these engines, and reviews their history. 3500 w. W Elect'n—July 21, 1900. No. 35474.

Test of a 550-Horse Power Gas Engine. Describes 5-hour tests, giving high results. 400 w. Eng Rec—July 7, 1900. No. 35152.

Test of Otto Gas Engine at Different Loads. A review of experiments on a 10 H.-P. engine. 800 w. Eng Rec—July 21, 1900. No. 35460.

Gas Engine Test.

Testing a 600-Horse Power Blast-Furnace Gas Engine. An account of the results of tests made with the Delamare-Deboutteville and Cockerill engine. Ill. 1500 w. Col Guard—June 22, 1900. No. 35114 A.

Gasoline Motors.

Pattern Making for Gasoline Motors. W. O. Anthony. The first of a series on pattern-making for small gas engines intending to fully cover the subject. Ill. 3500 w. Horseless Age—July 18, 1900. Serial. 1st part. No. 35297.

Ignition.

Premature Ignition in Gas Engines. E. W. Roberts. Discusses the effects of ignition in advance of the proper time, the location of the ignition points, with illustrations of faults in engine design. 1500 w. Mod Mach—July, 1900. No. 35122.

Oil Engine.

Low Cost Power for Electric Lighting, Pumping, Machine Shops, etc. Charles Hansel. Illustrated description of a 25-H.-P. oil engine, and a statement of the advantages from its use. 2200 w. R R Gaz—July 20, 1900. No. 35445.

Power Development.

See same title under Steam Engineering.

Valves.

The Valves of Internal Combustion Engines. James D. Roots. Considers recent and existing practice, giving illustrations. 4000 w. Engr, Lond—July 20, 1900. No. 35625 A.

STEAM ENGINEERING.

Boilers.

Boilers at the Paris Exhibition. General review of the exhibits, noting the preponderance of the water-tube type. 1900 w. Engr, Lond—June 22, 1900. Serial. 1st part. No. 35108 A.

A Letter on Soda, in Answer to an Inquiry. W. H. Edgar. On the action of soda ash or caustic soda in steam boilers. 2200 w. Loc Engng—Aug., 1900. No. 35577 C.

The Prevention of Scale and Corrosion in Boilers. R. D. Summerfield. The need of water analysis, the use of soda, and the treatment of acid waters and other substances are discussed. 2400 w. Elec Eng, Lond—July 20, 1900. No. 35584 A.

The Solignac Circulating Boiler (Sur la

Chaudière Mixte, Système Solignac). A. Brüll. An illustrated description of a boiler in which the water circulates from a large upper reservoir through tubes in which it is converted into steam, which then returns to the upper part of the reservoir. 1200 w. Bull de la Soc d'Encour—May 31, 1900. No. 35564 G.

See also Marine and Naval Engineering; Marine Boilers and Water-Tube.

Boiler Accidents.

The Efficacy of Boiler Inspection in the German Empire (Ueber die Wirksamkeit der Dampfkesselüberwachung im Deutschen Reiche). C. Bach. A review of accident statistics, showing that accidents due to boiler explosions, etc., have diminished considerably in proportion to other accidents. With tables and curves. 1000 w. Zeitschr d Ver Deutscher Ind—June 23, 1900. No. 35301 D.

Explosion of a Water-Tube Boiler at Deptford. Report of the British Board of Trade, of interest because of its special bearing on the management of water-tube boilers. 2200 w. Engr, Lond—June 29, 1900. No. 35217 A.

Condensers.

Evaporative Condensers. Harry G. V. Oldham. An interesting and extended description, with plates, discussion of advantages, principles, etc., and lengthy general discussion. 23400 w. Inst of Mech Engs—April, 1899. No. 35200 D.

Heat Distribution.

Experiments with a Boiler Arranged to Serve as a Calorimeter for Determining the Heating Value of Fuel. Charles J. Slipper, Mortimer Harrison, Jr. and Edward C. Schmidt. Graduation thesis. Tests made at Stevens Inst. to determine the heating value of coal under the conditions of its use with a boiler. Ill. 6500 w. Stevens Ind—July, 1900. No. 35616 D.

High-Speed Engine.

High-Speed Vertical Triple-Expansion Engine; Central Electric Station, Vienna, Austria. Illustrated description of an engine installed in an electric-lighting station which possesses many features of interest. Special attention is called to the method of governing. 1100 w. Eng News—Aug. 2, 1900. No. 35689.

Power Development.

The Future of Power Development. Wm. D. Ennis. Considers the probability of displacement of the steam engine by other motors, or its radical improvement in the matter of economy. 2300 w. The Engineering Magazine—Aug., 1900. No. 35638 B.

Pumping-Engines.

The Pumping-Engines in the City of Philadelphia. Henry G. Morris. A brief description of the different styles and types of pumping-engines that have been and now are in use. Also discussion. 6000 w. Pro Engs' Club of Phila—July, 1900. No. 35277 D.

Steam Engines.

The Efficiency of the Steam Engine. Ed. C. de Segundo. Remarks on the Behrend and Zimmerman engine, and results obtained from other engines. 1000 w. Elec Rev, Lond—June 22, 1900. No. 35088 A.

Steam Turbine.

The Parsons Steam Turbine at Elberfeld (Die Parsons-Dampfturbine). A short illustrated description of a steam turbine driving a 1,000-kilowatt dynamo. 1 plate. 300 w. Schweiz Bauzeitung—June 16, 1900. No. 35363 B.

Steam Turbines (Die Dampfturbinen). A well illustrated description of various Laval and Parsons turbines in practical operation. Serial. 2 parts. 1 plate. 4000 w. Schweiz Bauzeitung—May 26, June 2, 1900. No. 35361 each B.

Test of a Steam Turbine Driving a Rotary Current Dynamo (Versuche an einer Dampfturbine mit Wechselstrommaschine). W. H. Lindley, M. Schröter and H. F. Weber. A full account of an acceptance test made of a Parsons steam turbine driving a 1,000-kilowatt rotary current dynamo in the city electrical works at Elberfeld, Germany. Serial. 2 parts. 6500 w. Zeitschr d Ver Deutscher Ing—June 30, July 7, 1900. No. 35302 each D.

Thermodynamics.

Graphic Calorimetry of the Steam Engine (Calorimétrie Graphique de la Machine à Vapeur). Fritz Krauss. (French translation by Ch. Bellens.) An illustrated account of graphical methods in thermodynamics, particularly of entropy diagrams. 9000 w. Rev de Mécanique—May 31, 1900. No. 35568 E + F.

Twin-Tandem Engine.

Twin-Tandem Hoisting Engine at the Scharnhorst Mine (Zwillings-Tandem-Fördermaschine der Zeche Scharnhorst). F. Schulte. An illustrated description, with diagrams and indicator cards. 2 plates. 1700 w. Glückauf—July 1, 1900. No. 35351 B.

Valve-Gear.

The Design of Cut-Off Slide-Valve Gear (Zur Beurteilung von Expansionsschiebersteuerungen). Prof. A. Bantlin. An illustrated article on the design of slide-valve gear, with special reference to the securing of ample admission of steam. 3500 w. Zeitschr d Ver Deutscher Ing—July 7, 1900. No. 35307 D.

MISCELLANY.

Aeronautics.

The New Air Ship of M. de Santos

Dumont. Francis P. Mann. Illustrates and describes an air ship that is to compete for the prize of 200,000 francs, offered by M. Henry Deutsch, of Paris. 1000 w. Sci Am—July 7, 1900. No. 35133.

Agricultural Show.

Royal Agricultural Show at York. Illustrates and describes some of the implements exhibited. 5200 w. Engr, Lond—June 22, 1900. No. 35110 A.

Breech Blocks.

Krupp Breech Blocks (Kruppsche Geschützverschlüsse). J. Castner. An illustrated description of various kinds of breech mechanism. Serial. 2 parts. 8000 w. Stahl und Eisen—June 15, 1900. No. 35330 each D.

Education.

Necessary Points in Mechanical Knowledge. Walter J. May. A criticism of many of the attempts made in the preliminary education of boys intended for mechanical trades. 1700 w. Prac Engr—June 22, 1900. No. 35092 A.

Engineering Education in the United States at the End of the Century. Ira O. Baker. Condensed address of the president of the Soc. for the Promotion of Engng. Ed., at N. Y. meeting. 2000 w. Ry Age—July 6, 1900. No. 35175.

Status and Tendencies of Engineering Education. Robert Fletcher. Read at N. Y. meeting of Soc. for Promotion of Engng. Ed. Disscusses whether the profession is overcrowded, the work of the schools, present conditions and apparent tendencies. 1500 w. Ry Age—July 6, 1900. No. 35176.

Etching.

The Levy Acid-Blast Method of Etching Metal Plates. Report of Franklin Inst. committee on the invention of Louis E. Levy. 1200 w. Jour Fr Inst—Aug., 1900. No. 35592 D.

Philadelphia Exposition.

The Export Exposition at Philadelphia in 1899 (Die Export-Ausstellung in Philadelphia, 1899). Richard Knoller. The official Austrian report, containing a general description of the exhibits, with illustrations. Serial. 2 parts. 10000 w. Zeitschr d Oest Ing u Arch Ver—June 8, 15, 1900. No. 35343 each B.

Printing Machines.

Some Printing Machines at the Paris Exhibition. Illustrates and describes the exhibits of printing machinery. 2400 w. Engng—June 29, 1900. No. 35221 A.

Prizes.

Program of Prizes Offered by the Société d'Encouragement in 1901 and the Following Years (Programme des Prix Proposés par la Société d'Encouragement pour l'Industrie Nationale à Décerner dans les Années 1901 et Suivantes). A long list of general and special prizes and medals offered in various departments of science and art. 10000 w. Bull de la Soc d'Encour—May 31, 1900. No. 35566 G.

Standardization.

Standardization. J. E. Sweet. Read before the Engine Builders' Assn. of the U. S. Showing the advantages of making and using standard sizes. 2800 w. Am Mach—July 19, 1900. No. 35432.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Little Things at Anthracite Collieries. Lee C. Morganroth. Calls attention to ingenious devices for making use of materials which would otherwise be wasted. 1700 w. Mines & Min—July, 1900. No. 35189 C.

Brown Coal.

Brown Coal Mining in the Rhineland. Information concerning the character of the deposits and methods of working. 1000 w. Jour Soc of Arts—June 22, 1900. No. 35085 A.

Classification.

The Chemical Classification of Coal. Clarence A. Seyler. Read before the So. Wales Inst. of Engs. A discussion of the methods of classification, giving views of writers of note, and examining the results of the graphic method, and data on which various classifications are based. 6000 w. Col Guard—July 6, 1900. Serial. 1st part. No. 35285 A.

Coal-Cutting.

On Coal-Cutting Machines in the United States. A. Bachellery. Read before the Min. & Met. Cong. at Paris. Brief account of the types in use. 1000 w. Ir & Coal Trds Rev—July 6, 1900. No. 35410 A.

Coal Supply.

The Coal Reserves at the Close of the Nineteenth Century. Edward Hull. Abstract of an address at meeting of Victoria Inst., London. Discusses the export of this mineral from England, and things in reference to the supply that should be investigated by the Royal Commission. 2000 w. Ir & Coal Trds Rev—July 20, 1900. No. 35619 A.

The Present Coal Crisis in Europe. Abstract of an article in the latest monthly summary of the Commerce and Finance of the United States. Discusses the scarcity and price of coal and the causes. 3400 w. Ir & Coal Trds Rev—July 20, 1900. No. 35618 A.

Coke Ovens.

Semet-Solvay By-Product Coke Ovens. Brief paper read before the Brit. Inst. of Min. Engs. Illustrates and describes the plant at Wheeling, W. Va. 1200 w. Col Guard—June 22, 1900. No. 35116 A.

The Brunck Coke Oven. R. Brunck, in *Stahl und Eisen.* Describes this system and illustrates the newest large installation. 1700 w. Col Guard—July 13, 1900. No. 35509 A.

The Brunck Coke Oven System (Ueber Koksöfen System Brunck). Dr. R. Brunck. An illustrated description of the Brunck system, in which the heating of the two halves of the oven is entirely independent, the air is heated before reaching the coal, and provision is made for securing the by-products, tar, ammonia, benzol and illuminating gas. 1500 w. 1 plate. Stahl und Eisen—July 1, 1900. No. 35337 D.

Electricity.

Electricity in Collieries. Reviews its history, progress and present position, considering signalling, telephones, blasting and lighting. Ill. 6000 w. Col Guard—July 13, 1900. No. 35507 A.

Flooded Mine.

The Reopening of a Flooded Colliery. Charles Cooke. Extract from a paper in *The Journal of the British Society of Mining Students.* An account of a mine in the Lancashire coal field, once reopened, but again flooded, and still the water is flowing after seventeen years. 1500 w. Col Guard—July 6, 1900. No. 35288 A.

Ireland.

The Coal Fields of Ireland. Illustrates and describes the coal fields of Kilkenny and Tipperary, and the Connaught coal field. 3200 w. Col Guard—June 29, 1900. No. 35224 A.

Natal.

The Coal Deposits of Natal. An account of the character and quality of the deposits, with map. 900 w. Col Guard—June 22, 1900. No. 35115 A.

Paris Exhibition.

Coal Mining at the Paris Exhibition of 1900. Illustrated description of the mining exhibits of the different countries. 14000 w. Ir & Coal Trds Rev—June 29, 1900. No. 35220 A.

Safety Lamps.

Safety Lamps—Past and Present. Reviews the appliances used for lighting mines, illustrating many of the safety lamps. 3800 w. Ir & Coal Trds Rev—June 29, 1900. Serial. 1st part. No. 35-219 A.

Surface Arrangements.

Colliery Surface Arrangements for the Delivery of Coal from Pit Cage into Railway Wagons, for a Gross Quantity of, Say, 1,500 Tons per Day, Exclusive of Coal Washing and Coking. S. A. Everett. Illustrated description of best arrangement suited to colliery conditions in South Wales. 5500 w. Can Min Rev—July 31, 1900. Serial. 1st part. No. 35670 B.

Surface Arrangements at a Belgian Colliery. M. C. Minsier. From *Annales des Mines de Belgique.* Illustrated description. 3000 w. Col Guard. June 22, 1900. No. 35118 A.

Wyoming, Pa.

Dangerous Outcrops Under Quicksand Deposits. From the report of G. M. Williams. Illustrates and describes deposits in the Wyoming basin in Pennsylvania. and the reasons why their working is exceedingly dangerous. 1400 w. Ir & Coal Trds Rev—July 13, 1900. No. 35-498 A.

Ventilation.

See same title under Mining, below.

COPPER.

Chemistry.

The Chemistry of Copper. Charles Skeele Palmer. A discussion of the subject as viewed from the laboratory. 2500 w. Aust Min Stand—June 14, 1900. No. 35418 B.

Concentration.

Concentration of Ores by Petroleum. Charles M. Rolker. Read before the Mining Inst. Describes the important features of the Elmore process as practiced on copper rock, at Glasdir, Wales. 1800 w. Am Mfr & Ir Wld—June 28, 1900. No. 35099.

Copper Iron.

The Influence of Copper on Iron (Der Einfluss des Kupfers auf Eisen). W. Lipin. An account of the mechanical influence of a copper alloy in iron and steel, with the results of tests. Tables and illustrations. Serial. 2 parts. 5000 w. Stahl und Eisen—May 15, June 1, 1900. No. 35328 each D.

Production.

Copper Production and Consumption. Discusses the production, prices and consumption. 1600 w. Eng & Min Jour—July 21, 1900. No. 35461.

Queensland.

The Macarthur District. A Dewhurst Gore. Describes the silver and copper fields, and the development. 1800 w. Aust Min Stand—June 14, 1900. No. 35-422 B.

Refining.

Further Notes on Elimination of Impurities from Copper in Refining and Converting. Edward Keller. Supplementary information to a previous paper. 900 w. Trans Am Inst of Min Engs—June, 1900. No. 35519 D.

Spanish Copper.

The Rio Tinto Mines. An interesting description of these great mines in Spain. 6000 w. Aust Min Stand—May 24, 1900. No. 35212 B.

Tasmanian Copper.

The Tasmanian Copper Company and the Phœnix Syndicate. Editorial comment on the history of this company, and cautioning against too much confidence in the promises made. 1700 w. Eng & Min Jour—July 7, 1900. No. 35162.

GOLD AND SILVER.

Bokhara.

Mining in Bokhara. W. Rickmers. Describes the method of working the gold-bearing conglomerates of Asiatic Russia. 800 w. Aust Min Stand—June 14, 1900. No. 35420 B.

British Columbia.

A Trip to Rossland, British Columbia. Arthur Lakes. An illustrated account of some of the mines and the peculiarities of the ores. Also a description of the geology of shearage-zone fissure veins and facts regarding extent of development. 4500 w. Mines & Min—July, 1900. No. 35193 C.

Mining in British Columbia. Official facts from the report of the Minister of Mines, relative to the mining industry, product during 1899, etc. 600 w. U. S. Cons Repts, No. 780—July 14, 1900. No. 35227 D.

Mount Sicker District, Vancouver Island. W. M. Brewer. Describes the copper deposits, the geology, and the development. 1800 w. Eng & Min Jour—July 21, 1900. No. 35462.

Progress on Vancouver and Texada Islands. W. M. Brewer. Shows the varied and important deposits, and the progress of development work. 1600 w. Eng & Min Jour—July 14, 1900. No. 35263.

British Guiana.

Gold Mining in British Guiana. John H. Powell. Read before the Inst. of Min. & Met., Lond. Part first describes the country and deposits and methods of mining. 2500 w. Aust Min Stand—June 14, 1900. Serial. 1st part. No. 35421 B.

Butte.

The Mines of Butte. Arthur Lakes. An account of the large bodies of copper ore and the crushing of timbers from the swellings of the walls; and a description of the formation and mines of the silver belt. Ill. 2500 w. Mines & Min—July, 1900. No. 35188 C.

Cape Nome.

Cape Nome, Alaska, Gold Region. Epitome of report by F. C. Schrader and A. H. Brooks, of the U. S. Geol. Surv. Concerning the formation of the country, and where and how the gold is found. Ill. 4300 w. Mines & Min—July, 1900. No. 35190 C.

Chloride.

The Chloride District, Arizona. Theo. B. Comstock. Much of the information given was gathered at the Elkhart mine and adjoining region. Gives an account of the development. 2700 w. Eng & Min Jour—July 28, 1900. No. 35544.

Cœur D'Alene.

Cœur D'Alene Mining Region. W. C. Clark. Facts in regard to the development of the country and the forms in which the minerals are found. 1800 w. Mines & Min—July, 1900. No. 35194 C.

Cripple Creek.

The Cripple Creek Volcano. T. A. Rickard. An illustrated explanation of the mining geology of this district and the method of formation. 9600 w. Trans Am Inst of Min Engs—June, 1900. No. 35513 D.

Dawson.

Notes from Dawson; the Koyukuk Region. An estimate of the output of gold for this season, and other information. 450 w. U. S. Cons Repts, No. 774—July 7, 1900. No. 35153 D.

Dredging.

Gold Dredging in New Zealand. P. G. Morgan. Describes the alluvial deposits showing the conditions which led to this industry, giving the history of early attempts at dredging, and describing types of dredges used. Ill. 3200 w. Eng & Min Jour—Aug. 4, 1900. Serial. 1st part. No. 35700.

Gold Dredging at Oroville, Cal. H. G. Parsons. An account of the work, the types of dredges in use, etc. 1000 w. Min & Sci Pr—July 7, 1900. No. 35260.

Hydraulic Mining.

California Hydraulic Mining Under the Caminatti Act. Explains the manner of occurrence and gives illustrated description of methods of hydraulic mining used. The difficulties which led to the passage of this act are also explained. 3400 w. Sci Am Sup—July 21, 1900. No. 35424.

Peru.

The Santo Domingo Gold Mine in Peru. F. C. Fuchs. Illustrated description of the deposits and account of the working. 1800 w. Eng & Min Jour—July 7, 1900. No. 35164.

Placers.

Placer-Mining in the Southern Urals.

Charles Tappan. An account of the results of an examination of part of the South Ural Placer District. 3000 w. Eng & Min Jour—July 14, 1900. Serial. 1st part. No. 35264.

The Testing of Flat Placer Deposits. Robert Nye. Discusses usual methods of testing, and the proper use of a well driller. 2400 w. Eng & Min Jour—July 14, 1900. No. 35265.

Pockets.

Pocket Mining in Southern Oregon. W. I. Fleck. Describes pocket deposits, especially in this district, with information concerning the prospecting. 1200 w. Eng & Min Jour—July 21, 1900. No. 35463.

Pyrites.

The Extraction of Gold from Auriferous Pyrites by Amalgamation. Thomas G. Davey. Read before the Inst. of Min. & Met., London. On the merits of the pan-amalgamation process, giving illustrated description. Ill. 2500 w. Eng & Min Jour—July 28, 1900. No. 35546.

Veins.

The Enrichment of Gold and Silver Veins. Walter Harvey Weed. A synopsis of the writer's theory and an explanation of its application to deposits of the precious metals. Ill. 8000 w. Trans Am Inst of Min Engs—June, 1900. No. 35517 D.

True Fissure vs. Shearage-Zone Veins. Arthur Lakes. On the probability that the origin and method of formation of both are practically the same. 1800 w. Mines & Min—July, 1900. No. 35195 C.

IRON AND STEEL.

Anthracite-Iron.

Reminiscences of the Early Anthracite-Iron Industry. Samuel Thomas. Reviews the use, growth and development of anthracite coal in the manufacture of pig-iron. Ill. 7500 w. Trans Am Inst of Min Engs—June, 1900. No. 35514 D.

Basic Process.

Present State of the Basic Process. M. G. Rocour. From a paper prepared for the International Congress, Paris. Considers the great extension of the basic Bessemer process and the causes, and discusses the effect on the iron manufacture. 1100 w. Col Guard—July 13, 1900. No. 35508 A.

Bertrand-Thiel.

Further Notes on the Bertrand-Thiel Process. Joseph Hartshorne. Summary of a report on the operations at Kladno, with general information. 1600 w. Trans Am Inst of Min Engs—June, 1900. No. 35521 D.

Blast Furnace.

A New Kind of Blast Furnace Construction (Ueber eine Neue Hochofenconstruction). F. Burgers. A paper before the Verein Deutscher Eisenhüttenleute, giving an illustrated description of blast furnaces built almost entirely of iron, with only a thin lining of brick, and cooled by water flowing over the outside. Serial. 1st part. 1600 w. Stahl und Eisen—July 1, 1900. No. 35336 D.

Projects for the Mechanical Charging of Blast Furnaces (Vorschläge zur Mechanischem Beschickung von Hochöfen). F. W. Lürmann. Various plans for traveling cranes for conveying ore, coke and flux to the mouths of two or more furnaces. 500 w. 1 plate. Stahl und Eisen —June 1, 1900. No. 35329 D.

Elba.

The Iron Ores and Blast Furnaces of Elba. Information concerning the arrangements being made for the erection of blast furnaces on this island, and the iron ores. 1600 w. Ir & Coal Trds Rev—July 6, 1900. No. 35409 A.

Germany.

Changing Conditions in the German Iron and Coal Markets. A statement of the situation and showing the gravity of the competition which producers will have to meet. 1800 w. U. S. Cons Repts, No. 781—July 16, 1900. No. 35228 D.

Iron Trade.

Industrial Depressions and the Pig-Iron Reserve. Geo. H. Hull. Points out the difference between a panic, caused by low prices, and a depression, caused by high prices, and presents statistics showing a close connection between abnormal prices for iron and reasons of great depression. Proposes reduction of iron prices and the creation of a reserve supply as efficient means for recovering stability. 7000 w. The Engineering Magazine—Aug., 1900. No. 35631 B.

Magnetic Ores.

Some Points in Connection with the Composition of Iron Ores. Part first deals with peculiarities of the magnetic ores. 2000 w. Col Guard—July 6, 1900. Serial. 1st part. No. 35282 A.

Nova Scotia.

The Iron Ores of Nova Scotia. George B. Cowlam. Describes new discoveries of magnitude and economic importance. 1500 w. Col Guard—July 20, 1900. No. 35624 A.

Recalescence.

The Theory of the Iron-Carbon Alloys, According to Osmond and Roberts-Austen (Die Theorie der Eisen-Kohlenstofflegirungen nach Osmond und Roberts-Austen). E. Heyn. An illustrated review of the work of Osmond and Roberts-Austen and others on iron-carbon alloys. Cooling-off curves are given and points of recalescence shown. 5500 w. Stahl und Eisen—June 15, 1900. No. 35332 D.

Slag.

The Determination of Slag in Iron and Steel (Die Bestimmung der Schlacke im Eisen und Stahl). Leopold Schneider. A description of methods of analysis. Serial. 2 parts. 3500 w. Oest Zeitschr f Berg u Hüttenwesen—May 19, 26, 1900. No. 35353 each B.

Specifications.

Specifications for Iron and Steel Work in Buildings. Maurice M. Sloan. Gives a sample specification. 4500 w. Am Archt —June 30, 1900. No. 35097.

Steels.

The Analysis of Chrome and Tungsten Steels. A. G. McKenna. Explains satisfactory methods used by the writer. 1000 w. Pro Engs' Soc of W Penna—April, 1900. No. 35429 D.

The Manufacture of Special Steels. L. Babu. Condensed from a paper read before the Met. Cong. at Paris. The critical points of special steels are discussed and their manufacture. 2500 w. Ir Trd Rev —July 19, 1900. No. 35426.

Sweden.

Some Little Known Iron Ore Deposits in Northern Sweden (Ueber einige Weniger Bekannte Eisenerz vorkommen im Nördlichen Schweden). Otto Vogel. An article, founded on Swedish official reports, describing the location of ore beds and giving analyses of ores, with tables and map. Serial. 2 parts. 1 plate. 5000 w. Stahl und Eisen—May 15, June 1, 1900. No. 35327 each D.

Sweden's Exhibit of Iron Manufactures at Paris (Die Pariser Weltausstellung. V. Schwedens Eisenindustrie-Austellung). A general account of the Swedish iron mining and metallurgical exhibit. 1000 w. Stahl und Eisen—June 15, 1900. No. 35333 D.

Thomas Steel.

See Civil Engineering, Bridges.

MINING.

Accidents.

The Red Ash Mine Disaster. James W. Paul. A description of the mine and conditions existing before the accident. 3200 w. Mines & Min—July, 1900. No. 35191 C.

Assessments.

The Assessment of a Coal Mine for Income Tax. Gives cases illustrating English law. 2200 w. Col Guard—July 6, 1900. No. 35283 A.

China.

Metal Mining in China. Herbert C. Hoover. Paper read before the Inst. of Min. & Met., London. Concerning the geography, geology and history of metal mining in the provinces of Chi-li and Shantung. Copper, gold and silver ore found and native methods of mining described. 3000 w. Aust Min Stand—June 7, 1900. No. 35416 B.

The Present Position of Mining in China (Die Gegenwärtige Lage des Bergbaues in China). Paul Speier. A list of the principal mining concessions to foreign companies, with some of the Chinese regulations governing concessions. 800 w. Glückauf—July 7, 1900. No. 35352 B.

Concentrating.

The Avino Mine, Mexico. Illustrates and describes the effective concentrating plant and the mine. 1600 w. Aust Min Stand—June 7, 1900. No. 35417 B.

Deep Mines.

Some Problems in Deep Coal Mining. H. M. Chance. Discusses the difficulties encountered and the systems for overcoming them. 1300 w. Jour Fr Inst—Aug., 1900. No. 35594.

Means for Counteracting High Temperatures in Deep Mines. Léon Poussigue. From a paper prepared for the International Cong. at Paris. States the prevailing conditions, and discusses the points needing attention, the use of fans, etc. Ill. 3500 w. Col Guard—June 29, 1900. No. 35225 A.

I. On the Working Conditions in Mines of Great Depth in Belgium. Simon Stassart. II. On the Working of Deep Mines. Joseph Hrabak. Two papers read at Min. & Met. Cong. in Paris. The first considers five of the deepest collieries in Belgium. The second considers winding arrangements. 2400 w. Ir & Coal Trds Rev —June 29, 1900. No. 35218 A.

Electric Appliances.

On the Employment of Electricity in Mines. Joseph Libert. Read before the Min. & Met. Cong. at Paris. Abstract. Information concerning the current most largely used, the applications, etc. 1200 w. Ir & Coal Trds Rev—July 6, 1900. No. 35411 A.

Electric Haulage at the Eureka Mines, Windber, Penn. A. S. M'Allister. Illustrated detailed description of the plant and power applications. 2500 w. Am Elect'n—July, 1900. No. 35177.

See also Electrical Engineering, Mining Machinery.

Explosives.

The Explosives Industry in 1899. Interesting particulars from the annual report of H. M. inspectors of explosives. 2400 w. Col Guard—July 20, 1900. No. 35620 A.

The Testing of Explosives for Mining Purposes. M. B. Lloyd. Report on the working of the British Government Testing Station for Explosives, for the year

1899. 3000 w. Col Guard—July 20, 1900. No. 35622 A.

Use of Safety Explosives. M. Delafond. From a paper prepared for the International Cong. at Paris. On the advances due to the investigations of the French Firedamp Commission. 1800 w. Col Guard—June 29, 1900. No. 35226 A.

Automatic Door for Underground Stores for Explosives. J. Jicinsky, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrates and describes a closing device used in Austria and approved by mining officials. 1000 w. Col Guard—July 20, 1900. No. 35623 A.

Comparative Blasting Tests with Dynammon No. 1 and Compressed Blasting Powder Cartridges (Vergleichende Sprengversuche mit Dynammon Nr. 1 und Comprimirten Sprengpulverpatronen). S. Heyda. An account of experiments in a salt mine with dynammon, a safety explosive consisting principally of ammonium nitrate, and blasting powder; with tables. 3200 w. Oest Zeitschr f Berg u Hüttenwessen—May 26, 1900. No. 35354 B.

Self-Closing Door for Underground Magazine for Explosives (Selbstthätiger Abschluss für Unterirdische Sprengmittelmagazine). J. Jicinsky. An illustrated description of an automatic door of a small magazine in a coal mine in Austria. 1 plate. 800 w. Oest Zeitschr f Berg u Hüttenwesen—July 7, 1900. No. 35360 B.

Hydrography.

Hydrographic Investigations of the U. S. Geological Survey in Their Relation to Mining. F. H. Newell. Explains the manner of carrying on these investigations and their value. Ill. 3000 w. Trans Am Inst of Min Engs—June, 1900. No. 35522 D.

Igniter.

Safety Shot Igniter. Illustrated description of a French device by which a fuse may be safely fired in a gassy mine. 1300 w. Mines & Min—July, 1900. No. 35192 C.

Mine Pump.

An Underground Pump at the Preussen I. Mine (Unterirdische Wasserhaltungsmaschine der Zeche Preussen I.). F. Schulte. An illustrated description of a compound Corliss steam pump, of novel construction. 2 plates. 1200 w. Glückauf—May 19, 1900. No. 35347 B.

Mining Conditions.

Mines and Miners. Reviews conditions in the British Isles previous to the reign of Queen Victoria, and the reports and evidence furnished by the Royal Commission, which led to legislation for bettering the condition of the miner and his child. 3400 w. Engng—July 20, 1900. Serial. 1st part. No. 35570 A.

Ore-Deposits.

The Secondary Enrichment of Ore-Deposits. S. F. Emmons. A statement of the writer's belief and argument sustaining it. 15700 w. Trans Am Inst of Min Engs—June, 1900. No. 35518 D.

Origin and Classification of Ore-Deposits. Charles R. Keyes. Considers the basis of classification and presents the scheme which commends itself to the writer. 10000 w. Trans Am Inst of Min Engs—June, 1900. No. 35512 D.

Some Principles Controlling the Deposition of Ores. C. R. Van Hise. A statement of the principles, and an explanation of their application to ore deposits, and their classification. 54000 w. Trans Am Inst of Min Engs—June, 1900. No. 35516 D.

Safety Lamps.

The Testing Station for Safety Lamps at Bismarck, Westphalia (Die Versuchsstation für Sicherheitslampen auf der Berggewerkschaftlichen Versuchsstrecke bei Bismarck i. W.). H. Fähndrich. An illustrated description of the apparatus and methods of testing. 2 plates. 2600 w. Glückauf—May 26, 1900. No. 35348 B.

Shaft Sinking.

Sinking a Shaft Through a 6.7-Meter Layer of Quicksand at a Depth of 155.5 Meters at Sollenau, Lower Austria (Durchteufung des 6.7m Mächtigen Schwimmsandes am Sollenauer Schachte Nr. 1, bei 155.5 m Teufe). K. Hoftich. An illustrated description of the work, in which a combination of methods was used, with costs. 1 plate. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 9, 1900. No. 35355 B.

Sinking Through Quicksand at an Austrian Colliery. K. Hoftich, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrates and describes the method adopted, which employed a wrought-iron caisson made of 2/5 in. plate, driven into the quicksand. 1300 w. Col Guard—June 22, 1900. No. 35119 A.

Soudan.

Mining Ordinance in the Soudan. A copy of the Mining Ordinance of 1899. 1400 w. N. Z. Mines Rec—May 16, 1900. No. 35210 B.

United States Minerals.

The Work of the United States Geological Survey in Relation to the Mineral Resources of the United States. Charles D. Walcott. An outline of what has been and is being accomplished by the Survey, with map. 7500 w. Trans Am Inst of Min Engs—June, 1900. No. 35520 D.

Ventilation.

A Combined Exhaust and Blast Fan for Colliery Ventilation. Illustrated description with a statement of the advantages of such fans. 900 w. Col Guard—July 6, 1900. No. 35284 A.

Composition of Mine Atmosphere. From a paper by Prof. Kotsowsky, prepared for the International Cong. at Paris. Concerning investigations made in Russia, and the results, Russian mine regulations, etc. 2300 w. Col Guard—July 20, 1900. No. 35621 A.

Wages.

Piece Rates of Miners' Wages and Sliding Scales. From a report on Standard Piece Rates of Wages and Sliding Scales in the United Kingdom. 1500 w. Col Guard—July 13, 1900. No. 35510 A.

Winding.

Winding from Great Depths. Léon Poussigue. From a paper for the International Congress at Paris. Discusses various systems for deep winding, and the most practical solution of the problem. Ill. 5500 w. Col Guard—July 6, 1900. No. 35287 A.

MISCELLANY.

Aluminothermie.

The Process of Generating High Temperatures by the Combustion of Aluminium with some Technical Applications Thereof (Verfahren zur Erzeugung Hoher Temperaturen durch Verbrennen von Aluminium und einige Anwendungen desselben in der Technik). Dr. Hans Goldschmidt. An illustrated account of the author's process for generating high temperatures by burning aluminium, with many applications, such as welding and repairing, and obtaining chemically pure metals. 4000 w. Glückauf—June 2, 1900. No. 35349 B.

Bosnia-Herzegovina.

Mining and Metallurgy in Bosnia and Herzegovina in 1899 (Das Berg-und Hüttenwesen in Bosnien und der Hercegovina im Jahre, 1899). General statistics, with tables. 1200 w. Oest Zeitschr f Berg u Hüttenwesen—June 30, 1900. No. 35359 B.

Fire Brick.

On Various Kinds of Fire Brick used in Germany (Ueber Verschiedene im Handel befindliche Chamottesteine). H. Hect, H. Leger and E. Cramer. A comparison of various German and foreign refractory bricks, with table giving chemical composition, specific gravity, resistance to heat and other data. 1500 w. Stahl und Eisen—June 15, 1900. No. 35334 D.

German Exhibit.

The German Metallurgical Exhibit at the Paris Exposition (Die Pariser Weltausstellung IV. Von der Deutschen Ausstellung für Hüttenwesen (Klasse 64). An illustrated account of some of the exhibits in the German section of the metallurgical department at the Paris Exposition. 1000 w. Stahl und Eisen—June 1, 1900. No. 35331 D.

Haiti.

Mineral Resources of Haiti; Railways. On the need of transportation facilities, and the mineral wealth of the island. 1000 w. U. S. Cons Repts, No. 783—July 18, 1900. No. 35289 D.

Lead.

The Lead Mines of Southeastern Missouri. Interesting information concerning the deposits of this district, the mining and concentration. 1800 w. Eng & Min Jour—July 28, 1900. No. 35543.

Metal.

The Nature and Yield of Metalliferous Deposits. Bennett H. Brough. Describes the principal ore-deposits of the world. Ill. 8300 w. Jour Soc of Arts—July 20, 1900. No. 35581 A.

Mica.

Mica and Mica Deposits. J. Ohly. Considers the peculiarities of mica and its demand, giving information regarding its preparation for market, etc. 1700 w. Min Rept—July 12, 1900. No. 35296.

Ore Shipping.

The Control of Lake Ore Shipping. Waldon Fawcett. Discusses the elements of strength held by the Rockefeller and other ore-moving interests. 1600 w. Am Mfr & Ir Wld—July 26, 1900. No. 35549.

Ozokerite.

Ozokerite. J. Ohly. Information where this mineral is found and account of the only two mines of any magnitude. 2200 w. Min & Sci Pr—July 7, 1900. No. 35261.

Paris Exhibition.

Mining and Metallurgical Exhibits at the Paris Exposition. Description of the exhibits, with a few illustrations. 3200 w. Eng News—July 19, 1900. No. 35441.

Philippines.

Prospecting in the Philippines. G. D. Rice. Reports plenty of metals, but must be developed at considerable cost. 1800 w. Am Mfr & Ir Wld—July 26, 1900. No. 35600.

Phosphate.

The American Phosphate Company's Plant Near Mount Pleasant, Tenn. George F. Blackie. Abstract of paper read before the Engng. Assn. of the South. Illustrates and describes the plant and its operation. 2000 w. Eng & Min Jour—July 7, 1900. No. 35163.

Quicksilver.

The Terlingua Quicksilver Mining District, Brewster Co., Texas. H. W. Turner. Brief account of the deposits, with illustration of a retort. 800 w. Min & Sci Pr—July 21, 1900. No. 35511.

Smelting.

Smelting in Durango, Mexico. H. Van F. Furman. Describes the ores and the method used. 1700 w. Aust Min Stand—June 14, 1900. No. 35419 B.

Zinc-Lead.

The Missouri-Kansas Zinc and Lead Mines. Harold A. Titcomb. An account of the development, with description of the ore bodies, ore treatment, etc. Ill. 1500 w. Eng & Min Jour—July 28, 1900. No. 35545.

Zinc.

The Purchase of Zinc Ores in the Joplin District. W. George Waring. Considers the selling of zinc ores on an assay basis the only rational system. 1500 w. Eng & Min Jour—July 14, 1900. No. 35-266.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. The detailed list and classified summary of train accidents for the month. 4000 k. R R Gaz—July 6, 1900. No. 35145.

Cost.

The Comparative Cost of Rail and Water Transportation in Europe. Information from important treatises of European engineers of high standing, giving facts regarding foreign costs of transportation. 2800 w. Eng News—July 19, 1900. No. 35439.

London Railways.

The Future of London Railways. G. F. Millin. Discusses the changes to the advantage of London, made possible by the inventions of the electric light, the use of electricity for light and traction, and the Greathead shield. 4200 w. Contemporary Rev—July, 1900. No. 35448 D.

Quarantine.

The Practical Phases of Quarantine as It Affects Railroads. A. W. Sullivan. Read before the International Assn. of Ry. Surgeons. Reviews the conditions and regulation of traffic, and discusses its value and effect from a railroad point of view. 3300 w. Ry Age—July 20, 1900. No. 35470.

Resistance.

Some Notes on Train Resistance. T. Lester Daniel. Considers the advantages to be gained by reducing resistance, and gives results obtained from a dynamometer car test, etc. 1500 w. N-W Ry Club—May, 1900. No. 35539 C.

Train Rules.

Superior Extras vs. Scheduled Trains—Proposed Rules. J. F. Mackie. Discusses proposed rules for the Can. Pacific Ry., and offers some suggestions. 1700 w. Ry Age—July 20, 1900. No. 35471.

FINANCIAL.

Railway Statistics.

Statistics of Railways in the United States for the year ending June 30, 1899. Information from the twelfth report of the Interstate Commerce Commission. 2400 w. Ry & Engng Rev—July 14, 1900. No. 35267.

MOTIVE POWER AND EQUIPMENT.

Axle Loads.

The Increase of Loads on Railway Cars (Die Erhöhung des Achsdruckes an Eisenbahnfahrzeugen). Rudolf Sanzin. A plea for increasing the loads on cars and locomotives in Central Europe so as to promote economy in transportation, with table of axle loads in Europe and America. 2000 w. Zeitschr d Oest Ing u Arch Ver—May 18, 1900. No. 35340 B.

Brake Beams.

Brake Beam Pressure. E. C. Schmidt. Describes experiments made by the Univ. of Illinois. Also an editorial. Ill. 2500 w. R R Gaz—July 27, 1900. No. 35603.

Cars.

New Parlor Cars. Illustrated description of the interior of two fine parlor cars in service on the C., M. & St. P. Ry. 600 w. Ry Age—June 29, 1900. No. 35-123.

Coke.

Coke Burning in France. George L. Fowler. Facts regarding the work done in burning coke on foreign railroads. 700 w. R R Gaz—July 20, 1900. No. 35-446.

Doors.

Grain Doors. H. C. Barnard. Read before the Cent. Assn. of R. R. Officers, Louisville, Ky. Reviews the doors which have been used, discussing their objections. 1100 w. St. Louis Ry Club—July 13, 1900. No. 35451.

Draft Appliances.

Draft Appliances of Extension Front. Thomas P. Whelan. Discusses the steaming qualities of engines, as affected by management of the draft appliances. 1800 w. Loc Engng—Aug., 1900. No. 35-578 C.

Freight Cars.

Capacity of Freight Cars. Short abstract of a report by Mr. de Marx, traffic manager of the Hungarian State Railroads. 450 w. R R Gaz—July 13, 1900. No. 35270.

Wooden Box Cars and Coal Cars of 100,000 lbs. Capacity; Southern Pacific Ry. Two-page plate with description and dimensions. 4200 w. Eng News—July 19, 1900. No. 35438.

The Most Economical Size of Freight Cars. L. F. Loree. Paper prepared for the International Ry. Cong. Abstract. Showing the advantages gained by the use of large capacity cars. 1600 w. R R Gaz —July 6, 1900. No. 35144.

Locomotive Practice.

Recent Locomotive Practice in France. M. Edouard Sauvage. Information concerning the seven great railway lines of France. Considers compound locomotives with four cylinders, other locomotives, and various details of construction. Ill. 6400 w. Inst of Mech Engs—1900. No. 35-199 D.

Locomotives.

A New Compound Locomotive. John Rickie. Describes an improved system of using steam expansively, appliable to all engines, but especially suitable to locomotive, electric light, and other engines which have to deal with variable loads. 2300 w. Engr, Lond—July 20, 1900. No. 35627 A.

The Pennsylvania's Class E-2 Experimental Locomotive. Outline drawing and description. 600 w. R R Gaz—July 20, 1900. No. 35443.

Richmond 10-Wheeled Locomotives—Finland State Railroads. Illustrations and descriptive specifications. 400 w. R R Gaz—July 6, 1900. No. 35143.

Rational Firebox Passenger Locomotive, C. & N. W. Ry. Illustration with description and comments. 1400 w. Ry & Engng Rev—July 28, 1900. No. 35617.

Report of Committee on Compound Locomotives. Abstract of a report presented by a committee of the Am. Ry. Mas. Mechs.' Assn. 2800 w. Eng News—July 5, 1900. No. 35187.

A Single-Wheeled Bogie Express Passenger Engine—Great Central Railway. Drawings and description. 1500 w. R R Gaz—July 27, 1900. No. 35604.

Four-Coupled Express Passenger Locomotive; Great Northern Railway Company (Ireland). Illustrations with brief description. 350 w. Engng—July 6, 1900. No. 35279 A.

Geared Locomotive for the McCloud River Railroad. Briefly describes this Californian road and gives illustrated description of the 60-ton Heisler geared locomotive. 1500 w. Engng—July 20, 1900. No. 35572 A.

Single-Expansion Engines with Piston Valves—State Railroad of France. M. Desdouits. From *Revue Générale des Chemins de Fer*. Abstract giving illustrations and principal dimensions, and a comparison of results with compound engines. 2700 w. R R Gaz—July 13, 1900. No. 35-269.

A Rebuilt Reading Locomotive. Illustrates and describes a Phila. & Reading engine, rebuilt by S. M. Prince, Jr., Supt. of motive power and rolling equipment. The boiler was raised to admit the change of wheels from 68½ to 78 in. in diameter. Wheel center is of cast-steel, and is cast solid. Cylinder fastenings are also novel, being entirely without bolts. 600 w. Loc Engng—Aug., 1900. No. 35576 C.

Paris Exposition.

Railway Rolling Stock at the Paris Exposition. Comments on the exhibits and regrets that American practice is not adequately represented. 4200 w. Eng News —July 5, 1900. No. 35184.

The State Railways of France at the Paris Exhibition. Illustrates and describes the exhibits of the Administration of State Railways in France. 2200 w. Engng—July 6, 1900. Serial. 1st part. No. 35-278 A.

Rating.

Some Observations on the Tonnage Rating of Engines. C. C. Riley. Extracts from a paper prepared for the July meeting of the Cent. Assn. of R. R. Officers. Discusses the lack of uniformity, the real object of tonnage rating, and the ideal method of engine rating. 3000 w. R R Gaz—July 20, 1900. No. 35442.

Rolling Stock.

The Advantages to Be Gained by Selecting Rolling Stock for a Given Service. Douglas T. Heap. Explains the traffic arrangements on the Waterloo and City Ry., England, and the alterations made by a service of single cars. 1000 w. Tram & Ry Wld—July 5, 1900. No. 35488 A.

Tires.

The Hönigsvald Method of Fastening Tires on Car Wheels (Ueber die Directe Radreifenverbindung (Patent Hänigsvald) vom Standpunkte der Technologie des Eisens). Albert Sailler. Abstract of an address before a branch of the Oest. Ing. und Arch. Verein, giving an illustrated description of a method in which the tires are partly pressed and partly shrunken on to the wheel. 1600 w. Oest Zeitschr f Berg u Hüttenwesen—June 30, 1900. No. 35358 B.

Train Lighting.

Oil Engines for Train Lighting. Alton D. Adams. Suggests a plan for lighting trains by electricity, using an oil engine and a dynamo in each car. Also editorial comment. 2700 w. R R Gaz—July 20, 1900. No. 35447.

Train Lighting. George D. Shepardson. Discusses the sources of lights, results produced and cost, but gives the greatest attention to the illumination of passenger cars. Ill. 8400 w. N W Ry Club—May, 1900. No. 35538 C.

See also Electrical Engineering, Lighting.

NEW PROJECTS.

Austro-Hungary.

The Causes and Effects of the Unequal Development of the Railways in Germany and Austro-Hungary (Ursachen und Wirkungen der Ungleichartigen Entwicklung des Eisenbahnwesens in Deutschland und in den Ländem der Oesterr.-Ungar. Monarchie). Carl Büchelen. A general historical review, and discussion of the present situation, with map and tables. 1 plate. 10000 w. Zeitschr d Oest Ing u Arch Ver—June 29, 1900. No. 35345 B.

China.

China in Regeneration. An Epoch and an Opportunity. John Foord. Considers the existing crisis as the birth of a new Chinese government, on a progressive basis, and reviews the enterprises already under way, especially the railway concessions. 2700 w. The Engineering Magazine—Aug., 1900. No. 35632 B.

The Railways of China. Information concerning the lines opened or being built, the style of rail used, and the equipment, with remarks on projected railways. 4000 w. Ir & Coal Trds Rev—July 13, 1900. No. 35499 A.

Improvements.

Railway Improvements in Formosa. Describes the very poor transportation facilities, and gives an account of a proposed line that will be a benefit to North Formosa. 1200 w. U. S. Cons Repts, No. 789—July 25, 1900. No. 35482 D.

Incline Railway.

Machinery for the Garesfield and Derwenthaugh Incline Railway. Illustrated description of the hauling plant for the road named. 1500 w. Engng—July 13, 1900. Serial. 1st part. No. 35501 A.

Military Railroads.

Roads and Railways in Military Operations (Ueber Strassen und Eisenbahnen im Aufmarsch-und Operationsraum eines Heeres. Tertiärbahnen für den Localverkehr als Kriegsbahnvorrath). Col. Tilschkert. A paper before the Verein f. d. Förderung d. Local und Strassenbahnwesens, advocating stone tracks with automobiles, and other auxiliary means of transportation. 6000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—May, 1900. No. 35379 D.

New Zealand.

A Mountain Railway in New Zealand. A. P. Godber. Illustrated description of the Rimutaka Incline, and its equipment. 1000 w. Loc Engng—Aug., 1900. No. 35575 C.

Paris.

The New Lines of the Western Railway in Paris and its Vicinity (Die Neuen Bauten der Französischen Westbahn in Paris und Umgebung). E. A. Ziffer. Paper before the Verein f. d. Förderung d. Local u. Strassenbahnwesens describing the various improvements by which the railroad now reaches the Esplanade des Invalides, with maps and illustrations. 1 plate. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—June, 1900. No. 35381 D.

PERMANENT WAY AND BUILDINGS.

American Rails.

Iron and Steel Rails in America. Robert W. Hunt. Read at London meeting of Am. Soc. of Civil Engs. Reviews the history of rail-making and railroad building, giving interesting information. 6000 w. Engng—July 6, 1900. Serial. 1st part. No. 35281 A.

Ballast.

Ballast. A. Feldpauche. Abstract of a report to the International Railroad Congress on the properties of good ballast, choice to be made between ballast of different qualities, etc. 2200 w. R R Gaz—July 13, 1900. No. 35268.

Crossings.

Highway Crossing Alarms. J. S. Evans. Read at Detroit, before the Assn. of the Ry. Tel. Supts. Discusses automatic alarms, and the requirements for protection of crossings. 1200 w. R R Gaz—July 20, 1900. No. 35444.

Paris.

Work on the Courcelles-Passy Section of the Line from Courcelles to the Champs de Mars (Ligne de Courcelles au Champ-de-Mars, à Paris. Travaux de la Partie Comprise entre Courcelles et Passy.) A. Dumas. A very fully illustrated description of improvements made by the Western Railway on this section of its Paris terminal lines. 2 plates. 5000 w. Génie Civil—July 7, 1900. No. 35394 D.

Rail Joints.

Rail Joints, Particularly Those on Street Railways (Der Schienenstoss, Insbesondere bei Strassenbahnen). Phil. Fischer. An account of improvements in rail joints, with many illustrations showing sections of rails made by the Phœnix Company of Laar. 1300 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—May, 1900. No. 35380 D.

Some Notes on Rail Joint Fastenings. F. C. Schmitz. Outlines the history of the angle-bar joint, and a discussion of its constructive features. Ill. 3800 w. R R

Gaz—July 27, 1900. Serial. 1st part. No. 35602.

Renewal.

Maintenance of Way. Abstract of reports of F. Tettelin and L. A. Denys, to the International R. R. Congress, on systems for maintenance and renewal of permanent way on lines of heavy traffic so as to avoid slackening speed of trains. 1800 w. R R Gaz—July 13, 1900. No. 35272.

Signaling.

Remarkable Progress in Signaling. Editorial review showing the varied character of the enterprise and expansion during recent years. 2500 w. R R Gaz—July 27, 1900. No. 35605.

Signals.

Signal Device for Mines. C. S. Herzig. Illustrated description of apparatus designed for a mine in Mexico. 1000 w. Trans Am Inst of Min Engs—June, 1900. No. 35523 D.

Station.

New Passenger Station at Richmond, Virginia. Illustrates and describes a union station in process of construction. 700 w. R R Gaz—July 13, 1900. No. 35271.

The Designing and Planning of Small Railroad Stations. Alfred Hoyt Granger. Discusses the requirements of town or country stations, giving many illustrations of recent work. 700 w. Br Build—July, 1900. No. 35524 C.

Steel Rails.

The Deterioration of Steel Rails. Editorial review of the report of a committee appointed by the British Board of Trade "to inquire what extent of loss of strength in steel rails is produced by their prolonged use on railways under varying conditions, and what steps can be taken to prevent the risk of accidents arising from such loss of strength." 3000 w. Engng—July 13, 1900. No. 35503 A.

Steel Ties.

Steel Ties on the Huntingdon & Broad Top Mountain R. R. Illustrated description of a form of steel tie which has been in experimental service for about six months. 800 w. Eng News—July 19, 1900. No. 35436.

Track Deformation.

Apparatus of M. Vassioutinsky for Registering Temporary Deformations in Railway Superstructures (Appareil de M. Vassioutinsky pour Enregistrer les Déformations Temporaires des Superstructres des Voies Ferrées). Translation from the Russian, describing a modification of the Ast apparatus for recording irregularities in the track. Illustrated. 1200 w. Bull de la Soc d'Encour—May 31, 1900. No. 35567 G.

TRAFFIC.

Rates.

Railway Rates and Charges for Electrical Machinery and Apparatus. Discusses the high rates for the transportation of this class of merchandise charged in England. 1500 w. Elec Rev, Lond—July 13, 1900. No. 35480 A.

STREET AND ELECTRIC TRAMWAYS

Alexandria.

The Tramway System of Alexandria (Le Réscau de Tramways de la Ville D'Alexandrie). T. Pollatcheck. A brief general description of the electric railway generating station and a few words about the line and rolling stock. 1000 w. Electricien—May 26, 1900. No. 35553 B.

American Practice.

Impressions of American Tramway Practice. A. E. Le Rossignol. Read at the Cardiff convention of the Munic. Elec. Assn. Impressions from a recent visit, with remarks on New York tramways. 2500 w. Elec Eng, Lond—July 20, 1900. No. 35586 A.

Austria.

Statistical Tables of the Austrian Local Railways for 1898 (Uebersichts-Tabellen Zusammengestellt aus der Statistik des Verbandes der Oesterreichischen Localbahnen für das Jahr 1898.) General engineering and financial statistics of 32 roads. 2000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—June, 1900. No. 35382 D.

Buenos Aires.

The Electric Lighting and Tramways of Buenos Aires. An illustrated detailed description. 2200 w. Elec Rev, Lond—July 13, 1900. Serial. 1st part. No. 35477 A.

Central London Ry.

The Central London Railway. A brief account of the opening and notice of the interesting features. 2000 w. Builder—June 30, 1900. No. 35211 A.

The Central London Railway. Editorial on the opening and operating of the electric railway. 2300 w. Engng—June 29, 1900. No. 35222 A.

The Central London Underground Railway. The first of a series of articles describing and illustrating this urban railway undertaking. 3000 w. Elec Wld & Engr—July 21, 1900. Serial. 1st part. No. 35464.

Como.

The Electric Tramway in Como. Illustrates and describes a line of novel construction, carried out in short time. A temporary concession granted to furnish transit for those visiting the Volta Exhibition. 1200 w. Tram & Ry Wld—July 5, 1900. No. 35491 A.

Corrosion.

Conditions of Electrolytic Corrosion in Brooklyn. Samuel Sheldon. An account of investigations carried out to determine the cause of the apparent immunity of cast iron in this extensive district. 2200 w. Trans Am Inst of Elec Engs—May, 1900. No. 35230 D.

Electric Traction.

Cost and Limitation of Electric Vehicle Traction. Alton D. Adams. Considers the cost of energy as furnished by the horse and by the steam engine, showing the cost of horse power to be about eleven times that of electric power, with much greater limitation. 2000 w. Sci Am—July 28, 1900. No. 35531.

Notes on Electric Traction Under Steam Railway Conditions. Edward C. Boynton. Discussions of this paper in New York and Chicago, and also a communication from M. H. Gerry, Jr. 12400 w. Trans Am Inst of Elec Engs—May, 1900. No. 35229 D.

Where Electric Traction Is Badly Needed. Editorial calling attention to the need of equipping the tunnels through which trains pass to and from the Grand Central Station in New York with electricity. 1100 w. Elec Rev, N. Y.—July 25, 1900. No. 35540.

Electrolysis.

Electrolysis of Underground Metal Structures. Dabney H. Maury. Condensed paper read before the Am. Water Works Assn., at Richmond, Va. Gives interesting experiments, and emphasizes the fact that the responsibility rests with the street railway companies. Ill. 5800 w. Eng News—July 19, 1900. No. 35437.

Electromagnets.

The Design of Tractive Electromagnets. W. Elwell Goldsborough. On the best methods in the design of this class of electromagnets. Mathematical. Ill. 7000 w. Elec Wld & Engr—July 28, 1900. No. 35601.

Elevated Roads.

Electric Traction "Not Entirely Satisfactory" for Elevated Railroads. Editorial on electricity as a motive power on elevated railroads. 800 w. Loc Engng—Aug., 1900. No. 35579 C.

Gauge.

On the Choice of a Gauge for Local Railways and Tramways (Ueber die Wahl der Spurweite für Lokal-und Trambahnen). A. Trautweiler. A consideration of the gauge question, with a discussion of the advantages and disadvantages of a narrow gauge. Serial. 1st part. 2400 w. Schweiz Bauzeitung—July 7, 1900. No. 35365 B.

Light Railways.

The Work of the Light Railway Commission. R. H. Scotter. Read at meeting of the Tram. & Light Rys. Assn. Reviews the history of the movement in England and the work of the commission, with suggestions. 2500 w. Engr, Lond—July 6, 1900. No. 35415 A.

London.

Overhead Electric Tramways for London. J. Clifton Robinson. History, illustrated description and argument. 10600 w. Tram & Ry Wld—July 5, 1900. No. 35486 A.

Paris.

Local Transportation at the Paris Exposition. Henry Harrison Suplee. Discusses the problems of city-traffic and describes the solution found in connection with the Exposition, especially the travelling sidewalk. Ill. 2600 w. The Engineering Magazine—Aug., 1900. No. 35-635 B.

Electric Traction on the Extension of the Orleans Railway in Paris (La Traction Electrique sur le Prolongement de la Ligne D'Orleans dans Paris). J. A. Montpellier. A general description of the electrical equipment of this line along the Seine from the Place Valhubert to the Quai d'Orsay. 1200 w. Electricien—June 2, 1900. No. 35556 B.

Mechanically Operated Tramways in Paris (Die Bahnen mit Mechanischem Betrieb in Paris). An illustrated account of the different systems in use. Serial. 3 parts. 6000 w. Ill. Zeitschr f Klein u Strassenbahnen—June 1, 16, July 1, 1900. No. 35383 each C.

Polyphase.

Polyphase Electric Traction. C. A. Carus-Wilson. Read before the Inst. of Mech. Engs. Deals with this system and its application to railways, with illustrations from the Burgdorf Ry. in Switzerland, in part first. 3000 w. Engng—July 20, 1900. Serial. 1st part. No. 35574 A.

Power House.

See Electrical Engineering, Generating Stations.

Profits.

Profits on Tramway Undertakings. C. H. Gadsby. Read before the Tramways and Light Railways Assn., at Islington. Favors the electric equipment of tramways, showing that it increases the difference between gross receipts and working expenses. 2500 w. Elec Rev, Lond—July 13, 1900. No. 35478 A.

Railway Exhibition.

The International Tramways and Light Railways Exhibition, 1900. Concerning the large display of electric traction plant now on view at the exposition at Islington, England. 5500 w. Engng—June 29, 1900. No. 35223 A.

Snowdon Ry.

The Mechanical Equipment of the Snowdon Mountain Railway. Gowrie Colquhoun Aitchison. Descriptive account. 3500 w. Prac Engr—July 6, 1900. No. 35299 A.

Southampton, Eng.

Southampton Corporation Electric Tramways. Brief illustrated description. 2600 w. Elec Rev, Lond—July 20, 1900. No. 35588 A.

Surface Contact.

A New Surface Contact System for Electric Tramways (Ueber ein Neues Unterleitungs-System für Elektrische Strassenbahnen). H. Zacharias. A paper before the Verein für Eisenbahnkunde giving a well illustrated description of the Steudebach system, in which contact is made with the working conductor by means of a simple mechanical arrangement. 5500 w. Glaser's Annalen—June 15, 1900. 35323 D.

Swansea.

The Swansea, Wales, Tramways. Illustrated detailed account. 2800 w. Elec Eng, Lond—July 6, 1900. No. 35407 A.

Three-Phase Ry.

The High-Speed Three-Phase Railway from Toledo to Norwalk, Ohio. Illustrated detailed description. 3500 w. Elec Rev, N. Y.—July 25, 1900. No. 35541.

Ticket Machine.

An Electric Automatic Ticket Machine for Electric Railways (Elektrische Fahrkarten-Automat für Elektrische Bahnen). An illustrated description of a coin-in-the-slot machine for supplying tickets on electric cars, which is operated by electromagnets. 1200 w. Elektrizität—June 9, 1900. No. 35386 C.

Transition Curves.

Transition Curves Used by the Boston Elevated Railway. Gives tables arranged to suit the requirements of this road, with explanatory remarks. 2300 w. St Ry Rev—July 15, 1900. No. 35434 C.

Transportation.

Electric Traction. Rankin Kennedy. Considers the probability of the motor car eventually driving out electric traction. 1100 w. Elec Rev, Lond—July 13, 1900. No. 35479 A.

Travelling Sidewalk.

See Paris, above.

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